REPORT

OF THE

SUPERINTENDENT

OF THE

U.S. COAST SURVEY

FOR

1859

With the compliments of

Prof. A. D. Bache,

Supt. U. S. Coast Survey.

J. S. Schanck

36TH CONGRESS, } 1st Session. } SENATE. { Ex. Doc.

REPORT

OF

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SHOWING

THE PROGRESS OF THE SURVEY

DURING

THE YEAR 1859.

WASHINGTON:
THOMAS H. FORD, PRINTER.
1860.

LETTER

FROM THE

SECRETARY OF THE TREASURY,

COMMUNICATING

The Report of the Superintendent of the United States Coast Survey.

IN THE SENATE OF THE UNITED STATES, *April* 18, 1860.

Resolved, That there be printed, in addition to the usual number, six thousand two hundred copies of the Report of the Superintendent of the Coast Survey for the year 1859; 1,200 copies of which for the use of the Senate, and 5,000 for distribution by said Superintendent; that the same be printed and bound with the charts and sketches, in quarto form, and that the printing of said charts and sketches shall be done to the satisfaction of the Superintendent of the Coast Survey.

ASBURY DICKINS, *Secretary.*

TREASURY DEPARTMENT, *February* 6, 1860.

SIR: I have the honor to present, for the information of the House of Representatives, a report made to the Department by Professor A. D. Bache, Superintendent of the United States Coast Survey, stating the progress in that work during the year ending November 1, 1859, accompanied by an engraved map showing the general progress made in the survey of the Atlantic, Gulf, and Pacific coasts, and also the manuscript map prepared at the Coast Survey Office, in accordance with an act of Congress approved March 3, 1853.

With great respect, your obedient servant,

HOWELL COBB,
Secretary of the Treasury.

HON. JOHN C. BRECKINRIDGE,
President of the Senate of the United States.

ABSTRACT OF CONTENTS OF REPORT.

CONTENTS OF APPENDIX.

I.—FIELD, HYDROGRAPHIC, AND OFFICE DETAILS.

A.—GENERAL LISTS OF COAST SURVEY PARTIES AND RESULTS.

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ALPHABETICAL INDEX.

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ERRATA.

In Coast Survey Report for 1858.

Page 114, line 19 from bottom, for "inspector" read "*Engineer*."
Page 114, line 16 from bottom, for "in the harbor" read "*outside of the harbor*."
Page 122, after "tidal observations" dele "*with the self-registering tide gauge*."
Page 279, line 2 from bottom, for "month" read "*mouth*."

In Coast Survey Report for 1859.

Page 36, 1st line, insert "δ" before "Ursæ Minoris."

REPORT.

COAST SURVEY STATION, COOPER, WASHINGTON COUNTY, MAINE,
September 23, 1859.

SIR: In compliance with the law of 1853, and with the regulations of the Treasury Department, I have the honor to present my report on the progress of the Coast Survey of the United States during the surveying year, from November 1, 1858, to November 1, 1859.

As the scale of the work, depending upon the amount of the appropriation made for its progress, is the same this year as the last, the report will go over nearly the same extent of ground as the former one. A general view of the progress from the real commencement in 1832, to the present time, is shown in a map prepared for the purpose, (Sketch No. 36,) and will presently be referred to particularly.

The survey has again been in progress in its land work, hydrography, or office work, in the twenty-two seaboard States, and Territories of the United States, in which it is not essentially completed.

I propose to retain the same divisions in the present report as in those immediately preceding it, namely, the introduction, the description of operations, and the Appendix.

I. The introduction discusses briefly the progress of the work under separate heads and gives the estimated progress for the next year, and the means necessary to secure it, thus bringing together the work done and the appropriation required for that amount of progress.

II. In the second part a detailed account is given under the head of sections, arranged geographically, of the field, hydrographic, and office work done during the year. The sections are numbered from one, beginning at the northeastern boundary, to nine, terminating with the southern line of Texas, and including the Atlantic and Gulf coast of the United States. Sections ten and eleven, including the western coast, begin at San Diego, and terminate at the forty-ninth parallel of latitude. Under each head the work is described in the general order of its execution, as 1. Triangulation; 2. Topography; 3. Hydrography, with statistics of the several operations, and other particulars relating to the work. Each chapter is prefaced by a brief reference to the progress made in the sections, and by a statement of the office work pertaining to it.

III. The Appendix contains information useful to navigators, commercial men, surveyors, and men of science, with such lists and papers relating to the work as could not conveniently be introduced into the body of the report. It is subdivided, for purposes of ready reference, into the following heads: 1. *Field, hydrographic, and office details*, embracing general lists of the parties and their occupation as distributed along the coast; the names of officers of the army and navy attached to the work; data furnished from the archives in reply to applications made within the year; the statistics of field and office work; a list of surveys made on the Western Coast; the developments made in the course of the regular hydrography; tide tables

for navigators, and a table of the depths at important port entrances on the Atlantic, Gulf, and Western Coast; detailed reports of work performed in the office divisions; lists of the topographical and hydrographical sheets registered within the last two years; and lists of the geographical positions furnished by data received from the field within the same period. 2. *Special operations and scientific discussions* relating to magnetism, tides, and currents. 3. *Local surveys*, comprising descriptions of special localities, their topographical features, and their resources.

4. *Miscellaneous scientific matters* relating to methods and instruments. 5. *Correspondence incidental to the operations of the survey.* 6. *Light-house matters* referred to the Board for consideration.

The first part of the introduction shows the progress and gives the estimates for the next year's progress. The last contains remarks upon work done, and especially upon the parts which are not referred to in the body of the report.

GEOGRAPHICAL SECTIONS—ESTIMATES OF PROGRESS AND COMPLETION.

In my report for 1857 I estimated the time of completion of the work on the Atlantic and Gulf at from ten to twelve years, estimating upon the "present resources and regular rate of progress," and showed how this could be accomplished by the same resources from the direct estimates and the aid derived from the Navy, War, and Interior Departments. In my next report I stated that "the available means from different sources for this last fiscal year, (1858–'59,) were ninety thousand dollars less than for the former," (1857–'58.) "These appropriations were less by $30,000 than those for the previous year, 1857–'58, besides which, no appropriation was asked by the Interior Department for the survey and marking of the Florida keys, and of the islands off the Western Coast, making a diminution of $90,000 in the available means for the progress of the survey in 1858–'59." The portion of this reduction which fell upon the field and office work of the Atlantic and Gulf sections was $40,000, being about eleven per cent., or more than one-tenth, requiring an increase of rather more than one year in ten, in the estimated time of completion. It is not to be expected that this decrease will show itself in a marked way in two years, except in those sections which have suffered most from it, but I cannot be responsible for it when it does appear.

I have carefully revised the estimates of progress and completion presented in my report of 1856–'57, and, adopting the same order of discussion as given in that report, now proceed to give the results, which will be found in accordance with the statements then made.

SECTION I. *From Passamaquoddy bay to Point Judith, including the coast of the States of Maine, New Hampshire, Massachusetts, and Rhode Island.*—The primary triangulation is carried to the northeastern boundary of the United States, requiring merely the occupation of certain stations passed by in order to advance the coast work, to complete the original scheme from Point Judith (Rhode Island) to the limits of Maine.

Three secondary triangulation parties will finish the triangulation in six years, and the progress will show whether this is the best course, or to press on the topography, employing only occasionally a third triangulation party, so as to complete the triangulation in seven and a half to eight years. The completion of the primary work of this section will give means from the estimates to furnish the additional topographical parties needed to keep fully up with the secondary triangulation. Two hydrographic parties with steam vessels and one with a sailing vessel will keep the hydrography close upon the triangulation and topography. The progress made this season shows that there will be no difficulty in this respect.

Allowing a margin of two years brings us to the estimate of my report for 1856–'57, namely, "ten to twelve years" from that date, or eight to ten from this, even without the additional year already referred to.

A map has been marked off with the limits of average progress, as determined by the statistics of the survey, to be expected in the triangulation of this part of the coast, and will enable me to regulate the progress accordingly. In two years the same may be done for the topography and hydrography.

SECTION II. *From Point Judith to Cape Henlopen, including the coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.*—The parties which, from time to time, can be spared to work upon the rivers of this section and upon revision, will easily bring to a close the small portion of outstanding work within the time estimated for the completion of the other sections.

SECTION III. *From Cape Henlopen to Cape Henry, including the coast of part of Delaware, and the coast of Maryland and part of Virginia.*—The remaining work in this section, which is small, compared with that already executed, between one and two tenths, is provided for in the estimates and steadily advancing. It will easily be completed within the time named for the other sections.

SECTION IV. *From Cape Henry to Cape Fear, including part of the coast of Virginia and North Carolina.*—The primary triangulation of Pamplico sound and its rivers, not commenced at the date of my report of 1856–'57, has had one season's work upon it, and will regularly advance to its completion. The parties are provided which will bring all the work of this section to a close within the time estimated for section I, and that without burdening other parts of the survey. The plans for prospective operations are quite matured.

SECTION V. *From Cape Fear to the St. Mary's river, including part of the coast of North Carolina and the coast of South Carolina and Georgia.*—The same number of parties should be kept in this section for another year as heretofore, after which one or more can be spared for other work, and yet complete the section in the time required for section I. Two secondary triangulation parties would complete that work in five years. The question of the character of the primary work, and of bases of verification, will be settled, probably, in another year, certainly in two. The hydrography of the section is well advanced, the ocean part of it especially.

SECTION VI. *From St. Mary's river to St. Joseph's bay, including the eastern and western coasts of the peninsula of Florida, and the Florida reefs and keys.*—The expedient of a line across the head of the peninsula, by which the triangulations of the Atlantic and Gulf coasts will be connected, changes essentially the character of the triangulation necessary around the peninsula, and alone renders possible the completion of this section within the time required for section I. In fact, it will require great exertion and steady execution of plans to succeed in this. Three triangulation parties on the eastern side, and two on the western, will be required to make this sure. I rely upon parties available after two years, from other sections, to bring up any arrears which we may find in the section; but it may be most prudent to add a year to my estimate of 1857, and to make it eight to nine years from the present date, which is the same limit as of section I. The topography keeps well up with the triangulation, and so does the hydrography, the reef being nearly completed, so that the time of completion of this section may be safely estimated as not greater than for section I. The reduction of thirty thousand dollars, furnished

by the Interior Department for the Land Office surveys prior to 1858 fell heavily upon this section.

SECTION VII. *From St. Joseph's bay to Mobile bay, including part of the coast of Florida and the coast of Alabama.*—Of this section I stated in my report for 1857 as follows: "This was the last section commenced, and it is perhaps between one-sixth and one-fifth done. It will require additional force to put it through in ten to twelve years. This may probably be had as the Atlantic sections require fewer parties to bring them to a close; but I cannot foresee positively yet. Good progress has been made since we commenced this work, in 1852, and there are three centres of operation—near Pensacola, near Apalachicola and St. Mark's, and near Cedar Keys. If we had means to employ a steam vessel here throughout the season there would be no doubt of the completion of this section with the others."

I shall make a strong effort to procure an additional hydrographic party for section IX, so that the steam vessel available for this section shall be constantly employed here. No effort shall be spared to bring the section up to the others in its progress. The reduction of the appropriation has prevented the supply of an additional party during the last two years.

SECTION VIII. *From Mobile bay to Vermilion bay, including the coast of Mississippi and of part of Louisiana.*—The work in this section makes steady progress, and the topography is kept close to the triangulation, being, in fact, connected with it generally. With the force now in the section it will not be difficult to finish the triangulation, as estimated in 1856–'57, in eight years from this present date, and to complete the work at the same time with section I. As remarked in my report for 1856–'57, no one of the parties at work here can be spared for other sections, if this one is to be completed within the time estimated.

SECTION IX. *From Vermilion bay to the southwestern boundary, including part of the coast of Louisiana, and the coast of Texas.*—In my former report I supposed that additional force would be required to complete this section in time, and I am now sure of it. It may lag behind the other Gulf sections, unless means are furnished to push it onward. My notes show that I had intended to furnish another triangulation party to the section, had means sufficient been available, two years ago.

WESTERN COAST.

SECTIONS X AND XI. *From San Diego to the forty-ninth parallel, including the coast of California and Oregon, and that of Washington Territory.*—It would be premature to attempt to estimate for the completion of this work, only commenced in 1850. The progress has been quite satisfactory, considering that the appropriation only provides for two triangulations, two topographical parties, another for triangulation and topography, and one hydrographic party. The harbors of this important coast have been surveyed, except those of Washington Territory, only a part of which are yet completed; and, besides a general reconnaissance, and the important work connected with the northwestern boundary between the United States and Great Britain, the general hydrography has been steadily prosecuted.

GENERAL STATEMENT OF PROGRESS.

The survey on the Atlantic and Gulf coast is nearly two-thirds done, and with the means appropriated for 1857–'58 can be finished, as then stated, in from ten to twelve years from that date. The revision of my estimates of time has, as already stated, confirmed this conclusion; and, at the present diminished rate of appropriation, we shall probably fall but one year behind

that period, if the present system is strictly persevered in to the close. In my report of last year I frankly stated the difficulties of accomplishing this result, and the circumstances under which alone I deemed it practicable. I would merely call attention to these, that I may incur no responsibility not properly belonging to such an arduous task.

I propose now to state, in the most brief form, the general progress of the survey. It will be seen, by reference to the general progress sketch, (No. 36,) that the triangulation of the Atlantic coast is continuous from the northeastern boundary of the United States to Little river, near the boundary between North and South Carlina, an extent of more than twelve hundred miles measured from point to point, and a proportional part of the whole Atlantic coast of two-thirds, as estimated in the same way, or of three-fourths as estimated by shore-line. I do not mean to say that the work is complete between these limits, because the secondary triangulation in some portions, and the primary in others, is not complete; but the work is a connected one, and as such is available for preliminary purposes. With an interval of but sixty miles, it is again connected to St. Simon's entrance, on the coast of Georgia, two hundred and twenty miles, leaving an interval of about thirty miles to the St. Mary's. From the St. John's it is nearly complete (with an interval of but eight miles) to Matanzas river, (St. Augustine.) Two parties will probably be at work this winter, advancing towards each other, from St. Augustine south and from Indian River inlet north; and, as soon as the appropriation will admit, a third will be placed here, to proceed from Indian river southward.

In the aggregate, the secondary triangulation of about seven-eighths of the Atlantic coast is completed.

From Cape Florida to the Marquesas the triangulation is continuous one hundred and seventy miles, and one or two seasons more will finish the intricate work of the inner keys and coast of Florida bay. The triangulation of Charlotte harbor is nearly completed; that of the Gulf coast extends from Chassahowitzka river to Cedar Keys—fifty miles; over Ocilla entrance; then from St. Mark's, beyond Apalachicola, to Indian Pass; over St. Andrew's bay; then from the middle of Santa Rosa sound to Pensacola entrance, including also Pensacola bay and its principal dependencies; from Mobile entrance, and up Mobile bay (westward) to Point Fortuna, in Isle au Breton sound, one hundred and thirty miles, and through Lake Borgne and Lake Pontchartrain, to New Orleans; over Bay Rondo and the passes of the Mississippi, and over Isle Dernière and Caillou bay; over Atchafalaya and East Côte Blanche bays; from East bay, (Galveston,) southward and westward, over Matagorda and Aransas bays and their dependencies, one hundred and ninety miles, to Aransas Pass, which is about a hundred and forty miles from our southeastern boundary.

The topography and hydrography based upon these triangulations have kept close pace with them, in some of the sections requiring the communication of results by the triangulation parties to the topographical parties, and in others by both triangulation and topographical parties directly to the hydrographic parties as soon as completed in the field.

The harbors of the Western seacoast of the United States, and many of the more important ones in the vast navigable sounds of the Pacific coast, have been surveyed, and the general triangulation from San Francisco as one centre and Santa Barbara as another, over Columbia river, in Oregon, in Washington sound and its dependencies, the Straits of Haro and Rosario and the islands between, to the northwestern boundary and southward into Puget's Sound, have been steadily pushed forward, and the topography and hydrography have followed closely.

The astronomical work has been kept up along the whole coast, as far as the progress of the

other operations rendered advisable. The latitudes and longitudes of the headlands on both coasts have been determined, and, with the intermediate stations, these make a total of seven thousand one hundred and seventy-eight points of which the geographical positions have been computed.

Preliminary determinations of longitude from Europe have been made by the best methods known to science. The telegraphic method of longitudes, perfected in connexion with the survey, has enabled us to connect the distant points—Calais, in Maine, and New Orleans, in Louisiana—with a certainty hitherto impossible. I am satisfied that a few signals by telegraph from America to Europe will enable us to determine the difference of longitude with a degree of accuracy which neither long-continued astronomical observations nor the transportation of chronometers have yet reached, or can ever reach. This is one of the works specially enjoined upon the Coast Survey by the plan of reorganization, and to which unvarying attention has been directed from the date of that plan until the present time.

The tide tables for navigators (Appendix No. 14) have been further revised for determining, by simple rules, the times and heights of high and low water in our different ports.

The magnetic elements, so important to the navigator and surveyor, have been further determined, and the tables now contain the results of observations made at over two hundred stations on all parts of the coast.

No less than three hundred and thirteen charts or sketches of harbors, inlets, shoals, sounds, bays, &c., have been drawn, engraved, and published, founded upon the land and hydrographic work of the survey.

PROGRESS FROM NOVEMBER 1858 TO NOVEMBER 1859.

The first table in the Appendix (No. 1) shows the distribution of the parties along the coast in the different sections, the officers employed, and the general limits of the work executed. A map of each section shows the work in some detail, and with convenient signs to denote the several operations. I give in this connexion a condensed account of the progress made in the field and office work, subdivided according to the eleven geographical sections of the survey.

SECTION I. *Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.—(Sketches A and A bis, Nos.* 1 *and* 2.)—The primary triangulation has been extended to the northeastern boundary of the United States, Howard mountain, near Machias, and Western Ridge, Cooper, Maine, having been occupied during the season. Observations for latitude and azimuth, and for the magnetic elements, have been made at the same stations, and the base on Epping Plain has been connected with the general triangulation. Chamcook has been occupied for the triangulation of Passamaquoddy bay and the St. Croix. The secondary triangulation has been continued in Penobscot bay, and connected with that extending southward and westward, over Muscongus bay, to Damariscotta river. The topography of Wiscasset bay has been completed, and progress made in that of Sheepscot river. The plane table survey of the Kennebec river and Merrymeeting bay has been nearly completed, and that of Casco bay has been extended eastward nearly to Harpswell. That of Cape Cod bay has been extended east and west, including the shores of Barnstable harbor, Mass., and verification of the topography done in the section is now in progress. The hydrography has been extended from Cape Newaggen and Damiscove island to Cape Small Point, outside of Kennebec entrance, and soundings have been made in Casco bay to join with former work abreast of and between Portland light and Green island.

The in-shore hydrography has been extended from Cape Elizabeth to Kennebunkport, Me., and soundings have been made between the Isles of Shoals, N. H. Deep-sea lines have been run from Cape Ann, across Cashe's Ledge, to Seal island, N. S., and thence by traverses to Machias, Mount Desert rock, Matinicus, and Manhegan island, to Portland entrance; and from Cape Elizabeth (southward) to Nausett Centre light, Cape Cod. The off-shore hydrography has been continued off the coast of Massachusetts. Revision work has been done in Salem and Hyannis harbors, and work for the examination of changes in parts of Boston harbor. Special magnetic observations have been made at Portland, Me., Portsmouth, N. H., and at several stations on Cape Ann, Mass. The tidal observations at Boston have been continued, and a tidal station has been established at Eastport, Me. Experiments with a new pressure tide-gauge have been made at Charlestown, Mass.

The drawing and engraving of additions to the chart of Boston harbor have been completed, as also the drawing of those of Portland harbor, Lynn harbor, and a new edition of that of Muskeget channel; and the engraving of the preliminary charts of Kennebec river and Rockport harbor. Progress has been made in the drawing and engraving of general coast chart No. II, from Cape Ann to Gay Head, and of preliminary coast chart No. 3, from Cape Small Point to Cape Cod; in the drawing of coast maps and charts No. 7, from Muscongus bay to Portland harbor; Nos. 9, 10, and 11, from Cape Neddick to Hyannis harbor, and No. 14, from Cuttyhunk island to Block island; also in the engraving of coast maps and charts Nos. 12 and 13, from Monomoy to New Bedford; the views for these charts, the finished maps of Kennebec river and Lynn harbor, and the new edition of the chart of Muskeget channel.

SECTION II. *Coast of Connecticut, New York, New Jersey, Pennsylvania, and part of Delaware.*—(*Sketch B, No.* 7.)—The triangulation of the Hudson river has been extended from Hudson northward, to connect with the work from Albany southward, at New Baltimore, and additional points have been determined near Yonkers. The topography of the Hudson has been continued, with intervals, north from the former limit to near Sing Sing on the eastern shore, and to Rock mountain on the western shore, including the delineation of the Palisades; that of Harlem river has been completed, and that of Long island, back of Brooklyn and Williamsburg, and in the vicinity of South Jamaica, has been filled in. The outlines of the new piers at Sand Point and Great Neck have been traced. The hydrography of the Hudson river has been in progress from Newburgh north to Poughkeepsie. A resurvey has been made of the shore off the Battery, New York city, for changes. Magnetic stations have been occupied at Hartford, Conn.; Springfield, Chesterfield, and Deerfield, Mass.; and at Rutland, Vt.; and minute current observations have been made off the western end of Long Island. Tidal observations have been continued at Brooklyn.

Progress has been made in the drawing and engraving of coast map and chart No. 22, New York bay and harbor, and in the drawing of the map of Hudson river, from its entrance to Sing Sing. New plates of the middle and eastern parts of the chart of Long Island Sound have been engraved, and the old plate of the chart of Captain's islands, East and West, has been re-engraved.

SECTION III. *Coast of Delaware, Maryland, and part of Virginia.*—(*Sketch C, No.* 9.)—The triangulation of the Potomac river has been extended from the mouth of the St. Mary's upwards, to the vicinity of Britton's bay; that of the James river has been completed by work at Hampton Roads, and a base measured near Claremont for verifying the triangulation of the upper James river and of the Appomattox. The topography of the outer coast of Maryland

has been continued, and that of the shores of Chincoteague bay completed. The shore line of the Patuxent has been traced from Holland's Point to Hall's creek, and that of the St. Mary's, Maryland, from its entrance upward to Warehouse Point, nearly completing the preliminary survey of those rivers. The shores of the James river have been traced between Westover and Little Brandon, completing the preliminary survey. The topography of the western shore of Chesapeake bay, between Rappahannock river and Mobjack bay, has been nearly completed. Soundings have been nearly completed in the Patuxent and St. Mary's rivers, and entirely in the James river, and the Big and Little Annemessex, dependencies of Tangier sound. Observations with self-registering tide-gauges have been kept up at the Washington navy yard and at Old Point Comfort.

The chart of York river, from King's creek to West Point, has been drawn and engraved for publication. The topography and lettering of coast maps and charts No. 31, Chesapeake bay, from its head to Magothy river; and No. 33, from Hudson river, Maryland, to the Potomac; of the finished chart of Patapsco river, and the outlines of coast map and chart from Green Run inlet to Little Machipongo inlet, (from a photographic reduction,) have been engraved. Progress has been made in the drawing and engraving of coast maps and charts Nos. 35 and 36, from Pocomoke sound to the entrance of Chesapeake bay; in the drawing of general coast chart No. IV, from Cape May to Currituck sound; of coast maps and charts Nos. 28 and 29, (the latter mainly by photography,) from Cape Henlopen to Little Machipongo inlet; No. 33 Chesapeake bay, the sheet of James river, from Richmond to City Point; and coast map and chart No. 37, from Cape Henry to Currituck sound; and also in the engraving of coast maps and charts No. 32 Chesapeake bay, from Magothy river to the Hudson, Maryland, and No. 34, from the Potomac to Pocomoke sound.

SECTION IV. *Part of the coast of Virginia and of North Carolina.—(Sketch D. No.* 15.)—The primary triangulation over Pamplico sound has been commenced. The triangulation of verification near New Inlet, Cape Fear, has been continued. The topography of the coast of Virginia, between Currituck sound and Cape Henry, has been completed. In-shore, hydrography on the coast of North Carolina has been extended from Bogue inlet, southward and westward, to New River inlet, and lines of soundings run between Cape Henry and Cape Hatteras, and observations in the Gulf Stream made in the vicinity of Cape Lookout.

Comparative charts of the Cape Fear entrances, showing the changes from 1851 to 1858, and diagrams, illustrating Gulf Stream explorations, have been drawn, and the former engraved upon stone, under the direction of the Superintendent of Public Printing. Progress has been been made in the drawing and engraving of preliminary coast chart No. 11, from Cape Hatteras to Cape Lookout; in the drawing of No. 12, from Cape Lookout to Cape Fear; in that of coast map and chart No. 48, from Bogue inlet to Barren inlet; and in the engraving of coast maps and charts Nos. 40 and 41, Albemarle sound.

SECTION V. *Coast of part of North Carolina and coast of South Carolina and Georgia.—(Sketch E, No.* 16.)—Astronomical and magnetic observations have been made at Cape Fear entrance, and the latitude, azimuth, and magnetic elements have been determined at Port Royal station. The triangulation has been extended south and west from Shallotte inlet to the boundary between North and South Carolina, and the shore line traced in connexion with it; signals have been erected and lines prepared for extending the primary work south and west of the Edisto base; the triangulation of Beaufort, Chechessee, and Colleton rivers, South Carolina, has been made, and that from Sapelo base extended southward across Doboy and Altamaha entrances to St. Simon's

sound. The topography has been continued southward and westward from Shallotte inlet; the preliminary survey between St. Helena sound and Savannah river has included the shore lines of Port Royal sound and the entrances of Beaufort, Broad, Chechessee, and Colleton rivers, and Calibogue sound. The topography of St. Catharine's sound has been nearly completed. The hydrography has been continued in-shore from Cape Fear entrance to Tubb's inlet, N. C., and the off-shore between Cape Fear and Charleston harbor. Soundings have been completed in Bull's bay, S. C., and a resurvey of Port Royal entrance has been made. The hydrography of the Chechessee and Colleton rivers, S. C., has been completed, and also that of Sapelo entrance and approaches. Tidal observations have been kept up in Charleston harbor.

In the drawing and engraving divisions additions have been made to the chart of Charleston harbor. The chart of Sapelo sound has been drawn and engraved, and the engraving of preliminary coast chart No. 14, from Cape Romain to Savannah river, has been in hand. Progress has been made in the drawing of coast maps and charts No. 53, from Charleston harbor to St. Helena sound; and No. 58, from St. Mary's river to the St. John's, Florida; and in that of the chart of Ossabaw sound.

SECTION VI. *Coast, reefs, and keys of Florida.—(Sketches F, Nos.* 20 *and* 21.)—The triangulation along the air line from Fernandina to Cedar keys has been continued to Waldo station. A preliminary base has been measured near St. Augustine, and the triangulation has been carried north towards Diego plains. A preliminary base has been measured at Indian river inlet, Florida, and signals erected for the triangulation north and south of Fort Capron. The triangulation of the inner bays has been extended eastward from Lignum Vitæ to Pigeon key Florida reef; and that of Charlotte harbor has been extended from Captiva pass northward to Punta Gorda. The topography of the western shores of Key Biscayne and Cards' sounds has been completed, as also on the western side of Key Largo, and the survey made of numerous keys between Lignum Vitæ and Oyster keys. The topography of Charlotte harbor has been continued northward from the former limit to Boca Grande. The hydrography of the Florida reef has been continued from Eagle cove to Coffin's Patches; the Gulf Stream has been explored through the Florida channel, and soundings made for depth and temperature in sections across it, from Carysfort light-house, Sombrero key, and the Tortugas. Tidal observations have been continued at St. Mary's river entrance, Tortugas, Charlotte harbor, and Egmont key, (Tampa.)

Progress has been made in the drawing and engraving of coast map and chart No. 68, Florida reef, from Key Biscayne to Carysfort reef; and in the drawing of Nos. 70, 71, and 72, Florida reefs and keys, from Long key to the Marquesas.

SECTION VII. *Part of the western coast of Florida.—(Sketch G, No.* 23.)—The triangulation has been carried from Crystal reef southward to the vicinity of Bayport; has been continued from St. George's sound to St. Mark's harbor, and from Pensacola bay into Santa Rosa sound. The topography has been continued nearly over the same limits. The hydrography has included a verification of the work at Cedar keys, and that at the eastern entrance of St. George's sound, including the new channel (Duer's) passing near Dog island. Tidal observations have been kept up at Cedar keys, and at Warrington, Pensacola harbor.

The drawing and engraving of the preliminary chart of the eastern part of St. George's sound have been completed, as also the engraving of the preliminary chart of Pensacola harbor. The drawing of the preliminary chart of Apalachicola bay has been finished at the

office, and since engraved on stone, under the direction of the Superintendent of Public Printing.

SECTION VIII. *Coast of Alabama, Mississippi, and part of Louisiana:—(Sketch H, No.* 26.)—The triangulation of Isle au Breton sound has been continued southward to Point Fortuna; progress has been made in that of Passe à Loutre; the SE. Pass of the Mississippi and of Bay Rondo, and that of Côte Blanche bay, has been extended westward nearly to the entrance of Vermilion bay. The topography of the shores of Lake Pontchartrain has been continued, and that of Isle au Breton sound has nearly kept pace with the triangulation; that of the SE. Pass of the Mississippi has been executed, and that of Côte Blanche bay has kept pace with the triangulation. The hydrography of Passe à Loutre has been executed, and that of Atchafalaya and Côte Blanche bay east completed. Some deep-sea lines of soundings have been run in the Gulf of Mexico.

The preliminary chart of Atchafalaya bay has been drawn and engraved, and the engraving of coast maps and charts Nos. 91 and 92, Mississippi sound and Mobile bay, from Bon Secours bay to Grand island, has been in progress.

SECTION IX. *Coast of part of Louisiana and coast of Texas.—(Sketch I, No.* 28.)—The triangalation has been carried from Matagorda entrance southward and westward over Espiritu Santo, San Antonio, Aransas, and Capano bays, and their dependencies. The topography has been extended along the shores of Espiritu Santo and San Antonio bays, and part of Matagorda island. The hydrography of Matagorda bay has been completed between the city and Palacios point.

The reconnaissance sketch of the entrance to Brazos river has been drawn and engraved, and progress has been made in the drawing and engraving of coast maps and charts Nos. 106 and 107, from Galveston bay to Matagorda bay; also in the drawing of coast maps and charts No. 105, Galveston bay, and No. 108, Matagorda bay. A general reconnaissance sketch of part of the coast of Texas, from Matagorda bay to Aransas Pass, has been drawn at the office, and was engraved on stone, under the direction of the Superintendent of Public Printing.

SECTION X. *Coast of California.—(Sketches J and J bis, Nos.* 30 *and* 31.)—The primary triangulation in the vicinity of the San Pedro base has been revised, and the secondary triangulation of San Pedro harbor executed, as also that of the northern part of Santa Rosa island, Santa Barbara channel. The primary triangulation from San Francisco entrance has been extended northward to Sulphur Peak, and the secondary connected with it carried over Drake's bay and Point Reyes. The positions of the Farrallones have been determined by triangulation. Crescent City harbor has been triangulated. The topography has included the harbor of San Pedro, part of Santa Cruz island, and Crescent City harbor. The hydrography of San Pedro harbor has been completed, and soundings off the approaches to the Golden Gate nearly so. A resurvey has been made of Humboldt bay, and the hydrography of Crescent City harbor executed. The regular tidal observations have been kept up at San Diego and near San Francisco.

The engraving of the charts of San Diego bay, Mare Island strait, and Humboldt bay has been completed, and also the drawing and engraving of the chart of the entrance to San Francisco bay. Progress has been made in the engraving of the chart of San Pablo bay, and additions have been made to the reconnaissance chart of the Western Coast. The map of San Francisco city has been engraved on stone, under the direction of the Superintendent of Public Printing.

SECTION XI. *Coast of Oregon and that of Washington Territory.—(Sketch K, No.* 34.)—The

triangulation of the Gulf of Georgia has been continued, stations on Point Roberts being connected with others on Galiano island above the forty-ninth parallel. Hydrographic reconnaisances have been made at the entrances to the Coquille river, Oregon, and at Gray's harbor, W. T., and general duty has been performed in connection with requirements of the commissioner on the northwestern boundary. The regular tidal observations at Astoria have been continued.

A new edition of the reconnaissance sketch of Canal de Haro and Strait of Rosario, and the chart of Port Townshend, have been drawn and engraved, and the engraving of the charts of Port Gamble and Semiahmoo bay has been completed.

MAPS AND CHARTS.

A series of projects of maps and charts, on suitable scales, has been prepared, for which the work now affords materials on the Atlantic and Gulf coasts. The projects for coast maps and charts on the scale of $\frac{1}{80000}$, as described in my report of last year, are one hundred and thirteen in number, embracing forty-two connected series. Those for the set of general coast charts, on the scale of $\frac{1}{4000000}$, are sixteen in number; and for a set of preliminary charts, on the scale of $\frac{1}{2000000}$, the projects are thirty-three in number.

The preliminary charts, with preliminary editions of harbor and other maps and charts, enable us to keep up with the work of each year. The electrotype process is especially valuable in enabling us to carry on this work without loss of the previous portions of the engraving. The application of photography, which is very far advanced, is making great changes in the facilities for reducing maps and charts. In another place I will present, at more length, a statement of our progress in this application.

Sixty-seven sheets have been worked upon in the drawing division within the past year. Of this number, two are finished charts, twenty-three finished maps and charts, thirteen finished maps, six preliminary charts, two comparative charts, nineteen sketches, and two sheets of diagrams. Thirty sheets have been completed and thirty-seven are in progress. Of those completed, four are finished maps, three preliminary charts, two comparative charts, nineteen sketches, including those showing field progress, and two sheets of diagrams.

In the engraving division, five first-class maps and new editions of three have been completed during the year, and twenty-one have been in progress. Of these last, eleven were commenced in former years and ten in the present year. Eleven second-class maps or charts and sketches have been completed within the year, nine of which were begun in the present year, and six of the same class are in progress. These, with five plates of diagrams, give a total of twenty-four completed and thirty-two in progress, or of fifty-six plates engraved or engraving within the year. In addition to those engraved upon copper, five charts and sketches have been engraved upon stone, under the direction of the Superintendent of Public Printing. The complete list, giving the titles of the maps and charts, will be found in Appendix No. 17. The general list of all the maps, charts, and sketches engraved up to the present date also accompanies the same Appendix. It includes two hundred and ninety-nine titles, of which sixty are first-class maps. The list is exclusive of twenty progress sketches which have been engraved, and receive additions from year to year, as the field-work advances.

The following list contains the titles of maps and charts, finished and preliminary, and of sketches and diagrams, accompanying this report, arranged geographically. The letters in the margin refer to the different sections; A to Section I, B to Section II, and so on. The

numbers on the maps, charts, and sketches correspond with those in the list which contains five finished charts, fifteen preliminary charts, and twenty sketches and diagrams.

1.—A. Progress sketch, Section I, (primary triangulation.)
2.—A *bis*. Progress sketch, Section I, (secondary triangulation, topography, and hydrography.)
3.— Seacoast of Maine, from Kennebec entrance to Portland.
4.— Portland harbor.
5.— Lynn harbor, Mass.
6.— Muskeget channel, (new edition.)
7.—B. Progress sketch, Section II.
8.— Hempstead harbor, Long Island Sound.
9.—C. Progress sketch, Section III.
10.— Chesapeake bay (sheet No. 4) from Potomac river to Pocomoke sound.
11.— Chesapeake bay (sheet No. 5) from Pocomoke sound to York river entrance.
12.— Chesapeake bay (sheet No. 6) from York river entrance to Cape Henry.
13.— Patuxent river, Md.
14.— St. Mary's river, Md.
15.—D. Progress sketch, Section IV.
16.—E. Progress sketch, Section V.
17.— Bull's bay, S. C., (new edition.)
18.— Port Royal entrance and approaches, S. C.
19.— Sapelo sound and approaches, Ga.
20.—F. Progress sketch, Section VI.
21.—F *bis*. Progress sketch, Section VI, (Florida reefs and keys.)
22.— Florida reefs and keys from Newfound harbor key to Boca Grande key.
23.—G. Progress sketch, Section VII.
24.— Cedar keys, (new edition.)
25.— St. George's sound, Fla., (eastern part.)
26.—H. Progress sketch, Section VIII.
27.— The Rigolets, La.
28.—I. Progress sketch, Section IX.
29.— Coast of Texas and Matagorda bay.
30.—J. Progress sketch, Section X, (lower part.)
31.—J *bis*. Progress sketch, Section X, (upper part.)
32.— San Pedro harbor, Cal.
33.— Crescent City harbor, Cal.
34.—K. Progress sketch, Section XI.
35.— Diagrams illustrating the distribution of temperature in the Florida straits.
36.— Sketch showing general progress in the survey of the Atlantic, Gulf, and Pacific coasts.
37.— Diagrams illustrating the results of magnetic observations at Girard College, Philadelphia.
38.— Lines of equal magnetic variation for the year 1858.
39.— Trowbridge's apparatus for deep-sea soundings.
40.— Mitchell's apparatus for measuring currents and improved pile for sea structures.

Constant efforts have been made to obtain a set of progress sketches better suited to popular

use, and yet useful for the purposes of the office. I believe that this may be accomplished for the next report, a plan which meets my approval having been finally hit upon after much experimenting.

The application of photography to the regular reduction of our maps and charts has made good progress. It is estimated that the cost of reducing one of our sea-coast charts by photography is but about one-fourth of that by the pencil and pen. The questions yet unsolved in this application are merely questions of detail, and it is to be considered as one of the processes fully applicable to the reduction of our maps and charts for engraving, no important difficulty in relation to which remains to be mastered. The report of the assistant in charge of the office, and of George Mathiot, esq., in charge of the photographic operations, give many important particulars in this matter, (Appendix No. 17.) Prints have been produced of reduced maps in which the severest tests could detect no error beyond the tolerated limits.

Mr. Mathiot is of opinion that we can profitably publish many of our preliminary maps by the photographic process without engraving at all, by issuing copies of the photographic prints themselves. Experiments will be made upon this at the earliest date practicable.

The operation of putting the print of the reduced map directly upon the copper, so as to avoid an intermediate tracing by the engraver, those of photo-lithography, and others, are in the course of experiment. Some successful trials have been made of photographing microscopic objects from the specimens of bottom of the sea collected in sounding.

ESTIMATES FOR THE FISCAL YEAR 1860-'61.

The estimates are in the usual form which attaches the work to be done, to the expenditure necessary to accomplish it, and so indicates the rate at which the survey is to be prosecuted, a larger expenditure being required to finish the work sooner, a smaller decreasing the work to be done, and therefore involving the time of completion. I have already, in last year's report, called attention to the fact that the entire appropriation for the fiscal year 1857-'58, exceeded by $90,000 (including the means furnished by the Land Office) that of the fiscal year 1858-'59, which was the same as that of 1859-'60, the item for the pay of engineers being introduced on the withdrawal of naval engineers from the work.

As it is absolutely essential in such a work to have latitude in regard to the details of progress of operations in order to conduct it efficiently, the sums assigned for the several sections are joined in the acts of appropriation into one, allowing to the Treasury Department, which controls by law the direction for the work, and under which the Superintendent acts, discretion in details, and merely confining the separate expenditures to the great divisions of the work, as the Atlantic and Gulf Coast; the Florida Coast, reefs, and keys; and the Western Coast. The whole of the expenditures for field and office work, including the pay of the civilians employed, is brought into these estimates. They include the expense of deducing the results, and drawing and engraving the maps, as well as of the surveys in the field.

These estimates suppose the same aid from the War and Navy Departments as heretofore. Should any part of this be withheld, the proportionate progress of the survey must of necessity be diminished.

The estimates were reduced in 1857-'58, during the great stress upon the treasury, and have not since been raised to their former level. This involves a less rapid completion of the work than the former rate, but in the uncertainty in regard to the means for the fiscal year, I have not ventured to recommend an increase. The several items now presented are the same

in amount as have twice met the approval of Congress. An additional item, as compared with the last two years, for fuel and quarters for officers of the army serving on the work, is to pay the emolument derived by law and no longer paid by the Quartermaster's Department from the general appropriation for fuel and quarters of the army. It is not a new item, but is intended to replace the balance of a former appropriation which permitted its omission in the estimates of last year and the year before, during the straightened condition of the treasury. This balance is now exhausted.

The assistant in charge of the work across the Florida line, Captain M. L. Smith, U. S. Topographical Engineers, advises me that the cost may be greater than was originally estimated by the officer who made the reconnaissance. I have, however, preferred to extend the time for completing the work rather than to ask an increase of the item for its execution. Even if Captain Smith's present estimate should be exceeded, the cost of the work will not reach one-fourth that of a continuous main triangulation around the coast, such as would be needed to connect the main work on the Atlantic and Gulf of Mexico.

No item of the estimates has been increased. That for the Western Coast has proved sufficient to keep the usual number of parties there in consequence of the work executed under the law for the Northwestern Boundary Commission.

Estimates in detail.

For general expenses of all the sections,* namely: rent, fuel, materials for drawing, engraving and printing, and ruling forms; binding; transportation of instruments, maps, and charts; for miscellaneous office expenses, and for the purchase of new instruments, books, maps and charts $19,000

SECTION I. *Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.* FIELD-WORK.—To continue the primary triangulation in this section and to make the necessary astronomical and magnetic observations connected with it; to extend the secondary triangulation up the *Penobscot river* and along the coast eastward from *Penobscot bay;* east from *Pemaquid* over *Muscongus bay*, and over the peninsula between the *Kennebec and Sheepscot rivers*, and of the coast east of those rivers; to commence the topography of *Penobscot bay*, and to continue that between *Kennebec river* and *Casco bay*; to continue the topography of *Cape Cod bay;* to complete the hydrography near the *Isles of Shoals*, New Hampshire; to continue the in and off-shore hydrography of the coast of Maine, from the *Kennebec entrance* eastward, and of the ledges off the coast of Maine; to make such tidal observations as may be necessary: OFFICE-WORK,—To make the computations connected with field-work; to commence the drawing and engraving of the chart of *Penobscot bay*, and that of *Casco bay;* to continue the drawing and engraving of general coast chart No. II, from *Cape Ann to Gay Head*, and preliminary coast chart No. 3, from *Cape Small Point to Cape Cod;* to complete the drawing and engraving of the chart of *Sheepscot river*, and the sketches of the section; to complete the drawing and engraving of coast map and chart No. 9, from *Cape Neddick to Cape Ann;* the engraving of that of *Kennebec river*, *Lynn harbor*, and coast maps and charts Nos. 12, 13, and 14, from *Nantucket sound to Narragansett bay;* to continue the draw-

*Viz: of all included in this item, inclusive of Sections I to IX, and exclusive of Section VI.

ing of coast map and chart No. 7, from *Muscongus bay to Portland harbor;* the engraving of the chart of *Portland harbor*, and of coast map and chart No. 10, from *Cape Ann to Plymouth;* and to commence the drawing of coast map and chart No. 8, from *Portland harbor to Kennebunk harbor*, and draw and engrave tidal diagrams, will require $43,000

SECTION II. *Coast of Connecticut, New York, New Jersey, Pennsylvania, and Delaware.* FIELD-WORK.—To complete the triangulation of the *Hudson river*, and to commence that of the *Connecticut;* to continue the topography of the shores of the *Hudson*, and to complete that of the approaches to *New York harbor*; to continue the hydrography of the *Hudson*, commence that of the *Connecticut river*, and execute miscellaneous work of revision in the section: OFFICE-WORK,—To make the computations required; to commence the drawing of the charts of *Hudson river*, Nos. 2 and 4, from *Sing Sing* north and *Troy* south; to draw and engrave the tidal diagrams and sketches of the section; to continue the engraving of coast map and chart No. 21, *New York bay and harbor*, and the finished map of *Hudson river* from the entrance to *Sing Sing;* and to commence the drawing and engraving of a chart of *Connecticut river*, will require 14,000

SECTION III. *Coast of Delaware, Maryland, and Virginia.* FIELD-WORK.—To continue the astronomical and magnetic observations required in the section; to examine and preserve the more important triangulation stations; to continue the triangulation of the *Potomac river;* to complete the topography of the *Patuxent and James rivers*; to continue that of the *Potomac*, and that of the outer coast of *Maryland*, including the bays connected with it; to complete that of the shores of *Chesapeake bay;* to continue the off-shore hydrography of the section, and work of verification in the *Chesapeake* and its tributaries; the hydrography of the *Potomac river*, and the tidal observations of the section: OFFICE-WORK,—To furnish the necessary computations; to complete the drawing and engraving of coast map and chart No. 33, *Chesapeake bay* from *Hudson river*, *Maryland*, to the *Potomac*, with the sketches of the section; the drawing of coast maps and charts Nos. 28 and 29, from *Cape Henlopen* to *Little Machipongo inlet;* Nos. 34, 35, and 36, *Chesapeake bay* from *Potomac river* to the entrance of the bay; and the engraving of charts of the *Patuxent and St. Mary's rivers;* to continue the drawing and engraving of sheet No. 6, *Rappahannock river*, from its entrance to *Deep creek;* the drawing of general coast chart No. IV, from *Cape May to Currituck;* the *Rappahannock river*, series Nos. 3, 4, and 5, from *Port Royal to Deep creek*, and the chart of *James river* from *Hog island to the Chesapeake;* to continue the engraving of coast map and chart No. 29, from *Green run inlet to Little Machipongo inlet;* coast maps and charts No. 32, *Chesapeake bay*, from *Magothy river to Hudson river*, *Maryland;* and Nos. 34, 35, and 36, of the same series, from the *Potomac* to the entrance of the bay; to commence the engraving of general coast chart No. IV, and that of coast map and chart No. 28, from *Cape Henlopen to Green run inlet*, will require 25,000

SECTION IV. *Coast of Virginia and North Carolina.* FIELD-WORK.—To continue the primary triangulation of *Pamplico sound* and the secondary connected with it; to complete the verification work near *Cape Fear entrance;* to continue the topography of the outer coast of *North Carolina* south of *Hatteras*, and to complete that of the *Chowan and Roanoke entrances;* to continue the in and off shore hydrography between *Cape Lookout and Cape Fear;* to continue the observations of tides and currents, and of the *Gulf Stream:* OFFICE-WORK,—To compute the results of the triangulation and other operations; to commence the drawings of coast maps and charts Nos. 42 and 43, *Pamplico sound;* to complete the drawing and engraving of the sketches of the section, the drawing of coast map and chart No. 48 from *Barren inlet to Lockwood's Folly inlet;* to engrave coast map and chart No. 40, *Albemarle sound* (western sheet;) to continue the drawing and engraving of preliminary coast chart No. 11 from *Cape Hatteras to Cape Lookout;* the drawing of coast map and chart No. 37, from *Cape Henry to Currituck sound;* preliminary coast chart No. 12, from *Cape Lookout to Cape Fear*, and general coast chart No. V, from *Currituck to Cape Fear;* to commence the drawing of coast map and chart No. 47, from *Bogue inlet to Barren inlet;* the engraving of coast map and chart No. 48, and that of preliminary coast chart No. 12, *Cape Lookout to Cape Fear*, will require $23,000

SECTION V. *Coast of part of North Carolina and that of South Carolina and Georgia.* FIELD-WORK.—To extend the triangulation in North and South Carolina, from *Tubb's inlet* southward towards *Winyah bay;* to extend the primary triangulation south of *St. Helena and Port Royal sounds*, and the secondary up the rivers connected with them; to measure supplementary bases on the coast of South Carolina and Georgia; to extend the triangulation south of *St. Simon's*, and over *St. Andrew's sound;* to continue the topography of *Port Royal sound*, and that between *Savannah river and Ossabaw*, including *Wassaw sound* and the rivers emptying into it; to continue the hydrography of *Wassaw*, *Ossabaw*, *and St. Catharine's sounds* and entrances; to complete that of *Doboy and Altamaha entrances;* and to commence, if practicable, that of *St. Andrew's entrance and sound;* to continue the tidal and current observations and investigations of the *Gulf Stream* in this and the following section: OFFICE-WORK,—To make the requisite computations; to complete the drawing and commence the engraving of coast map and chart No. 53, from *Stono inlet to Fripp's inlet;* to complete the drawing and engraving of charts of *St. Catharine's and Ossabaw sounds*, and the sketches of the section; the drawing of the chart of *St. Simon's sound*, and coast map and chart No. 58, from *St. Mary's to St. John's river;* to commence the engraving of charts of *Ossabaw and Sapelo sounds;* to continue the drawing of coast maps and charts No. 52, from *Cape Romain to Stono inlet*, and No. 54, from *Fripp's inlet to St. Catharine's sound*, and preliminary coast chart No. 14, from *Cape Romain to Tybee light;* to commence the drawing of preliminary coast chart No. 15, from *Tybee light to St. John's light;* and that of general coast chart No. VII, from *Winyah bay to the St. John's river*, will require 36,000

SECTION VI.—*Keys, reefs, and coast of Florida. (See estimates of appropriation for those special objects.)*

SECTION VII.—*Part of the western coast of the Florida Peninsula.* FIELD-WORK.—To continue the triangulation south of *Wechiwatchee river*, and north from *Suwanee river;* to continue that from *Apalachicola* westward of *Indian Pass*, and north of *Cape St. Blas;* to continue that of *Santa Rosa sound* and the dependencies of *Pensacola bay;* to make such astronomical and magnetic observations as may be practicable in the section; to continue the topography in connection with the triangulation as far as may be practicable; to continue the hydrography of the section from *St. George's sound* east and west, and from *Cedar keys* south and north, and to make the requisite tidal observations: OFFICE-WORK,—To make the necessary reductions and computations; to complete the drawing and engraving of the chart of *Santa Rosa sound*, *Escambia bay*, and *East bay;* the sketches of the section, and the engraving of the chart of *St. George's sound;* to commence the drawing of coast maps and charts Nos. 84 and 85, from *Appalachee bay to St. Joseph's bay*, and the engraving of coast map and chart No. 89, from *Pensacola bay to Mobile bay;* to continue the drawing of coast map and chart No. 81, from *Homosassa river to Cedar keys*, and that of No. 88, from *Choctawhatchee bay to Pensacola bay*, will require $33,000

SECTION VIII.—*Coast of Alabama, Mississippi, and part of Louisiana.* FIELD-WORK.—To continue the astronomical and magnetic observations required in the section; to continue the triangulation of *Isle au Breton sound*, and the triangulation of the *Mississippi delta* westward; to continue the triangulation over *Vermilion bay;* to complete the topography of *Lake Pontchartrain*, and to keep the topography up with the triangulations just enumerated; to continue the hydrography of *Chandeleur sound*, the *Mississippi passes*, and commence that of *Isle au Breton sound* and *Vermilion bay;* to continue the tidal and current observations and the deep-sea soundings of the Gulf in this section: OFFICE-WORK,—To make the requisite computations; to complete the drawing and continue the engraving of coast map and chart No. 92, *Mississippi sound*, from *Round island to Grand island;* to continue the drawing and engraving of preliminary coast chart No. 26, *Mississippi sound*, from *Mobile bay to Lake Pontchartrain*, and coast map and chart No. 100, from *Marsh island to Grand island;* to complete the drawing and engraving of a chart of the *Mississippi delta*, and the sketches of the section; the drawing of those of *Lake Borgne*, the *Rigolets*, and part of *Lake Pontchartrain*, and coast map and chart No. 93, from *Grand island to Lake Pontchartrain;* to commence the drawing of general coast chart No. XIV, from *Pensacola bay to Barataria bay;* to complete the drawing and engraving of the chart of *Atchafalaya bay;* to commence the drawing and engraving of that of *Côte Blanche bay*, and the drawing of that of *Vermilion bay*, will require 31,500

SECTION IX.—*Part of the coast of Louisiana and the coast of Texas.* FIELD-WORK.—To continue the triangulation southward from *Aransas Pass*, and the topography from *Matagorda entrance* southward and over *Aransas and Copano bays;* to con-

tinue the hydrography in and off shore from *Matagorda entrance* southward, and inside of *Matagorda bay* and its dependencies; to make the tidal observations which may be requisite: OFFICE-WORK,—To make the computations and reductions from field-work; to complete the drawing and engraving of coast maps and charts Nos. 106 and 107, from *Galveston bay to Matagorda bay*, and the sketches of the section; to complete the drawing and commence the engraving of coast map and chart No. 108, *Matagorda bay*; to continue the drawing and engraving of preliminary coast chart No. 31, from *Galveston bay to Matagorda bay;* to commence the drawing of coast maps and charts Nos. 109 and 110, from *Matagorda bay to Corpus Christi bay;* and the engraving of coast map and chart No. 105, *Galveston bay*, will require $25,500

Total for the Atlantic coast and Gulf of Mexico 250,000

The estimates for the Florida reefs, keys, and coast, and for the Western Coast of the United States, are intended to provide for the following progress:

SECTION VI. *Reefs, keys, and coast of Florida.* FIELD-WORK.—To continue the triangulation of the eastern or Atlantic coast of the peninsula, south of *Matanzas inlet*, and north and south of *Indian River inlet*; to complete the triangulation of the keys and sounds between the outer keys and the coast of the peninsula; to connect, if practicable, the *Marquesas* and *Tortugas*; to extend the triangulation north and south from *Charlotte harbor;* to make a part of the astronomical and magnetic observations required in the section; to continue the topography south of the *St. John's river*, and north and south of *St. Augustine harbor*, and, if practicable, over *Indian River inlet*, and northward of it; to complete the topography of the keys and coast of *Barnes' and Card's sounds* and *Florida bay;* to complete the topography of *Charlotte harbor;* to complete the hydrography of the *Florida reef*, and to execute off-shore work connected with it; to continue that of *Florida bay* and *Barnes' sound* and dependencies; to commence that of *Charlotte harbor*, and to keep up tidal observations at the *Tortugas*: OFFICE-WORK,—To make the computations connected with the field-work; to continue the drawing and commence the engraving of coast maps and charts Nos. 69 and 70, *Florida reef*, from *Garden key to Newfound Harbor key;* to continue the drawing and engraving of coast maps and charts Nos. 71 and 72, *Florida reefs*, from *Newfound Harbor key to Marquesas key*, and the drawing of preliminary coast charts Nos. 19 and 20, *Florida reefs*, from *Key Biscayne* to the *Tortugas;* to complete the drawing and engraving of coast map and chart No. 68, *Florida reef*, from *Key Biscayne to Carysfort reef;* that of *Charlotte harbor;* the sketches of the section; the drawings of *Indian River inlet* and *St. Augustine harbor;* and to draw and engrave the tidal and *Gulf Stream diagrams*, will require $40,000

SECTION X. *Coast of California.* FIELD-WORK.—To continue the triangulation along the Pacific coast northward of *Santa Barbara*, and to make the triangulations of *Santa Catalina* and *San Clemente islands;* to continue the primary and secondary triangulation north of *Drake's bay*, and to make such astronomical and magnetic

observations as may be necessary in that work; to execute topography within the triangulation of the *Santa Barbara channel*, main and islands; that of the dependencies of *San Pablo bay*, and such plane-table work as may be practicable, in addition to and connecting with the shores of *Drake's bay* and northward from *Point Reyes;* to continue the hydrography of the coast south and north of *San Francisco entrance*, and that of *Santa Barbara channel*, with such other as the progress of the survey may show to be first needed; to continue tidal observations in the section: OFFICE-WORK,—To make the necessary computations and reductions; to complete the drawing and engraving of a chart of *San Pedro harbor*, of *Crescent City harbor*, and of *Tomales bay*, and the sketches of the section; to continue the engraving of charts of *San Francisco and San Pablo bays*, and to commence the drawing of coast maps and charts north and south of *San Francisco bay*. Also, for the operations in

SECTION XI. *Coast of Oregon and that of Washington Territory.* FIELD-WORK.—To continue the triangulation of *Washington and Puget's sounds* and of *Hood's canal*, and the topography connected with it; to continue the hydrography of the *Gulf of Georgia*, and of *Washington and Puget's sounds* and their harbors, with such other hydrography as the progress of the survey may show to be expedient; to continue tidal observations in the section: OFFICE-WORK,—To make the necessary computations; to complete the drawing and engraving of a chart of *Coquille River entrance*, and make the additions to the hydrographic sketch of *Canal de Haro* and *Strait of Rosario*, and the progress sketches of the section, will require $130,000

For running a line to connect the triangulation on the Atlantic coast with that on the Gulf of Mexico, across the Florida peninsula, per act of March 3, 1843 5,000

For publishing the observations made in the progress of the survey of the coast of the United States, per act of March 3, 1843 5,000

For repairs of steamers and sailing schooners used in the survey, per act of March 2, 1853 10,000

For fuel and quarters and for mileage or transportation for officers and soldiers of the army serving in the Coast Survey, in cases no longer provided for by the Quartermaster's department, per act of August 31, 1852 5,000

For pay and rations of engineers for seven steamers used in the hydrography of the Coast Survey, no longer supplied by the Navy Department 12,800

The amounts thus estimated for the work of the fiscal year 1860–'61, and the appropriations for the present and two past fiscal years, are given below in parallel columns:

Object.	Fiscal year 1860–'61.	Fiscal year 1859–'60.	Fiscal year 1858–'59.	Fiscal year 1857–'58.
	Estimated.	*Appropriated.*	*Appropriated.*	*Appropriated.*
For survey of the Atlantic and Gulf coast of the United States, including compensation of civilians engaged in the work, per act of March 3, 1843	$250,000	$250,000	$250,000	$250,000
For continuing the survey of the Western Coast of the United States, including compensation of civilians engaged in the work, per act of September 30, 1850	130,000	130,000	130,000	130,000
For continuing the survey of the Florida reefs and keys, including compensation of civilians engaged in the work, per act of March 3, 1849	40,000	40,000	40,000	40,000
For running a line to connect the triangulation on the Atlantic coast with that on the Gulf of Mexico, across the Florida peninsula, including compensation of civilians engaged in the work, per act of March 3, 1843	5,000	5,000	10,000	15,000
For publishing the observations made in the progress of the survey of the coast of the United States, including compensation of civilians engaged in the work, per act of March 3, 1843	5,000	5,000	....	15,000
For repairs of steamers and sailing schooners used in the survey, per act of March 2, 1853	10,000	10,000	10,000	15,000
For fuel and quarters, and for mileage or transportation for officers and enlisted soldiers of the army serving in the Coast Survey, in cases no longer provided for by the Quartermaster's department, per act of August 31, 1852	*5,000	....	....	10,000
For pay and rations of engineers for seven steamers used in the hydrography of the Coast Survey, no longer supplied by the Navy Department	†12,800	12,800	12,800	....

* Formerly included in estimates of the War Department. † Formerly included in estimates of the Navy Department.

DEVELOPMENTS AND DISCOVERIES.

The general list, up to 1858, inclusive, is given in Appendix No. 8, and contains one hundred and sixty-one references to matters geographically arranged. My attention having been called by Geo. W. Blunt, esq., to the alleged grounding of a vessel on the Battery shoal, where it had been supposed there was water enough to float her, a re-examination of the shoal was made by Lieut. Comg. Craven, and the alarming state of things was developed which is stated in his report and in my letter to the New York Chamber of Commerce, copies of which are given in the Appendix No. 13. The following is a list for the last year:

1. Only eighteen feet at mean low water found on the rock one mile to the southward of Seguin island, coast of Maine.

2. True position of the Hussey Rock, in Casco bay, determined, correcting the erroneous one assigned on previous charts.

3. Determination of the position of the "Hue and Cry," the "Old Proprietor," and other dangers off Cape Elizabeth, Maine.

4. Development of a rock off Ogunquit, bare at low tides and very little known.

5. A fishing bank sounded out off Wood island, coast of Maine.

6. Huzzey's Rock, south of Fletcher's Neck, Maine, determined in position.

7. Development of a four-fathom bank off Cape Porpoise, Maine.

8. Determination of the position of a small rock with less than four feet at mean low water, near the channel, and in the vicinity of Great Rock, Hyannis harbor, Massachusetts.

9. The existence of a seventeen-foot spot on the shoal off the battery, New York harbor, the extension of the shoal towards the channel, and the shoaling of the water generally between the shoal and shore.

10. The existence and character of sub-currents ascertained, as bearing on the physical condition of New York harbor.

11. Changes developed in the shore lines at the entrance of Little Annemessex river, Chesapeake bay.

12. Less water found off Cape Romain by preliminary examination than has been heretofore assigned.

13. Further explorations in developing the character of the Gulf Stream in the Florida channel.

Changes were reported in Boston inner harbor which made a resurvey desirable, and the occasion was taken of the presence of one of the hydrographic parties in the vicinity to execute the work more fully reported under the head of Section I.

SURVEYS OF THE WESTERN COAST.

The reconnaissance of this coast having been made, and its chief harbors and entrances having been surveyed, the annual list heretofore given will be replaced by a biennial one.

During the past year, at the request of the authorities of San Pedro and Crescent City, minute surveys of those harbors were made and charts prepared on a larger scale than the previous charts of the same localities. A survey of Gray's harbor was directed, but circumstances preventing the land party from co-operating in it, a simple hydrographic reconnaissance was made. The survey of Coquille river entrance was also ordered, and would have been accomplished but for an accident to the hydrographic vessel. Special arrangements have been made by Commander Alden for its execution.

On the 15th of September the Treasury Department issued an order placing the steamer Active at the disposal of Lieutenant General Scott, and at the last advices from the Western Coast that vessel was undergoing repairs at the Mare Island navy yard, to be in readiness for such service as might be required under his orders.

TIDE TABLES.

The tide tables for navigators of the coast of the United States have been revised in the Tidal Division of the office, and additional results for the diurnal inequality in the ports of the Pacific coast have been interpolated from the observations and reductions at the regular tidal stations.

These tables (Appendix No. 14) contain the corrected establishment or mean lunitidal interval of one hundred and ten ports; the rise and fall of mean, spring, and neap tides, and the mean duration of flood, ebb, and stand. Simple rules for computing the time and height of high water, and for correcting the same for half monthly inequality, and for the daily

inequality where it is sufficient in amount to require notice, are given. The different peculiarities of the tides on the Atlantic, Gulf, and Pacific coasts of the United States are stated as derived from numerous observations. Easy rules for the tidal currents on the sea-coast of the Atlantic are also embodied in the explanatory notes to the tables.

TABLE OF DEPTHS.

In Appendix No. 15 is presented a revision of the table of depths which accompanied my report for 1857, with additions derived from results received at the office since that report was published, and from the latest data furnished by the Tidal Division. The table contains the depths that may be carried in at the entrances to principal ports and rivers, and that may be found at some of the more important anchorages on the several coasts of the United States. The compendious form in which this information is presented has been found very convenient for purposes of general reference.

LIST OF GEOGRAPHICAL POSITIONS.

The practical character of the triangulation is well shown in the resulting determinations of the latitude, longitude, and air-line ditances from each other of numerous points on all parts of the coast which have yet been reached in the operations of the survey. These are furnished by computation from the notes and journals of observations kept at the stations by the several field parties which occupy them. As being of general interest and of direct practical use to surveyors, navigators, and others, the geographical positions, as increasing in number, have been given in the reports of alternate years, beginning with that for 1851. In Appendix No. 20 of this report, one thousand six hundred and sixty-two additional positions are furnished, including points in all the sections of the coast, excepting Section IV. The progress sketches show the locations of the points, the latitudes and longitudes of which, with the bearings and distances from each other, are given in the form of tables.

The whole number of points determined, and of which the geographical positions have been published, amounts to seven thousand one hundred and seventy-eight.

TOPOGRAPHICAL AND HYDROGRAPHIC SHEETS.

In my report for 1856 lists were given with the scales, dates, and register numbers of all the plane-table sheets and original charts then on file in the archives. The lists given in the Appendix Nos. 18 and 19 contain the titles, &c., of the topographical and hydrographic sheets received and registered since that report was issued. To serve as an index for reference, the titles are arranged in geographical order, as in the former list.

INFORMATION FURNISHED.

Under an arrangement in the department which specially authorizes the communication of such data as the archives and records of the survey may furnish, on the conditions that due credit may be given for the same, and that the actual expense of copying the records be borne by the applicant, the usual calls have been met as heretofore—(Appendix No. 6.) As regards the general purpose of the work, this practice is merely incidental, but it requires no enlargement to show that all parts of the Union partake of the advantage derived from the regulation. The information, furnished on the terms alluded to, without any extra cost to the government, may be readily traced in general and elementary publi-

cations, and so has, in a measure, already returned of its first fruits to the people at large. Wherever interest is found in questions concerning the general geography of the country, it is clear that an accurate coast-line must ever be regarded as an important feature.

STATISTICS.

A revised table containing the statistics of field and office work is given in Appendix No. 7. It will readily be seen that the nature of the data given in some of the items renders the compilation of such a statement a matter of considerable difficulty and labor. Many of the plane-table and hydrographic sheets being required for purposes of reference in joining the new to former work, the statistical data which they would furnish without hindrance to the operations constantly going on at the south during winter, and at the north in summer and autumn, can be reached only by degrees in the process of distributing under the head of each year the work which properly belongs to it. This has at length been as nearly accomplished as the nature of the material and necessities of the work will allow. A systematic revision has been made of all the data, and provision for continuing the same from year to year upon a regular plan and with the same supervision, so that uniformity in the comparisons may be insured.

DISTRIBUTION OF REPORTS AND MAPS.

The lists kept at the office now contain the names of about four thousand individuals and public institutions to which the annual reports are sent regularly, as they are published. These lists have received additions, from year to year, of addresses referred by senators and members of the House of Representatives, and some have been registered on considerations connected with the known vocation and standing of the persons and institutions applying for them directly. About three hundred institutions of learning are embraced in the general list. The total stated is exclusive of a number of copies sent in exchange to foreign governments and societies, and of the miscellaneous distribution to individuals. In numerous cases calls made by the constituents of members of Congress after their complement of copies was exhausted have been supplied from the office, as are also the special applications constantly received from all parts of the Union, and from parties connected with the merchant service in the coasting trade. All the vessels of the navy and revenue marine, light-house inspectors, a large number of officers of both branches of the military service, custom-house officers, and others connected with the General Land Office in the States, and the Chambers of Commerce, Boards of Trade and Underwriters in the principal seaboard cities, have been regularly furnished in the same way. The total number of copies distributed within the year was six thousand one hundred and seventeen.

Of maps, charts, and sketches, over fourteen thousand impressions have been distributed since the date of my last report. More than half of these were sent to the principal departments of the government, to foreign institutions, and to certain libraries and other public depositories designated by members of the House of Representatives in their respective districts throughout the entire country.

It is expected that the Coast Survey Report for 1858, ordered by the last Congress to be printed, will, with its maps and charts, be published by the energetic Superintendent of Public Printing in the early part of the session, anticipating by many months the former rate of publication.

REPORT OF COMMITTEE OF TWENTY.

At their meeting in 1857 the American Association for the Advancement of Science appointed a committee of twenty,* to examine anew into the character and progress of the Coast Survey. A report had been made by a committee in 1849, and a new examination was desired. The conclusions of this committee, after a most elaborate investigation of the subject, are given in their report,† as follows:

"With these voluntary and emphatic testimonies to the character of a work as magnificent in its scientific aspects as it is valuable in those which are purely utilitarian—testimonies, moreover, emanating from sources which rank, in point of authority, among the highest known to the scientific world—the committee might be justified in closing a report already protracted beyond their expectation. After the extended review, however, which they have taken of the purposes in which this great undertaking originated, of the history of its growth, and the expansion of the processes involved in its execution, and of the brilliant results which have already crowned its diversified labors, it will probably be expected of them that they should condense the final expression of their opinions into a form sufficiently concise to be comprehended at a single view. As the succinct recapitulation, therefore, of the conclusions at which they have arrived, the committee, with entire unanimity, concur in stating the following propositions:

"1. The American Coast Survey, in its inception, was a work imperatively demanded by a due regard to the industrial interests of the country, dependent, as they are, greatly upon the prosperity of commerce for their free development.

"2. The indecision which marked the early policy of the government in regard to this survey, and the consequent delay of its efficient operations, and postponement of its beneficial results, were of manifest disadvantage to the material welfare of our people, and cannot but be still subjects of serious regret.

"3. The economical value of such surveys is attested by the universal voice of all com-

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* 1. Judge J. K. Kane, President Amer. Phil. Society, Penna.
2. Gen. Joseph G. Totten, Chief Engineer U. S. A.
3. Prof. Benjamin Peirce, Harvard College, Mass.
4. Prof. John Torrey, U. S. Assay office, N. Y.
5. Prof. Joseph Henry, Secretary Smithsonian Institute, D C.
6. Prof. J. F. Frazer, University of Pennsylvania, Penna.
7. Prof. Wm. Chauvenet, U. S. Naval Academy, Md.
8. President F. A. P. Barnard, University of Mississippi, Miss.
9. Prof. John Leconte, College of South Carolina, S. C.
10. Prof. Wm. M. Gillespie, Union College, N. Y.
11. Prof. F. H Smith, University of Virginia, Va.
12. Prof. W. H. C. Bartlett, U. S. Military Academy, N. Y.
13. Prof. Wolcott Gibbs, Free Academy, N. Y.
14. Prof Stephen Alexander, College of New Jersey, N. J.
15. Prof. Lewis R. Gibbes, Charleston College, S. C.
16. Prof. Joseph Winlock, Supt. Am. Naut. Alm., Ky.
17. Prof. James Phillips, University of North Carolina, N. C.
18 Prof. Wm. Ferrel, Nashville, Tenn.
19. Prof. Edward Hitchcock, Amherst College, Mass.
20. Prof. James D. Dana, Yale College, Conn.

† Report on the history and progress of the American Coast Survey, up to the year 1858, by the committee of twenty appointed by the American Association for the Advancement of Science, at the Montreal meeting, August, 1857.

mercial men, and by the concurrent practice of all commercial nations, no less than by the melancholy records of marine disaster annually occurring upon every unexplored coast.

"4. Their scientific value is witnessed, in the instance of the American Survey, by the spontaneous tributes of approval frequently and freely bestowed upon it—no less in regard to the ability, energy, and skill displayed in its management than to the magnitude, variety, and oftentimes curious interest of the results it has wrought out—by individuals and organized bodies of men whose high position as scientific authorities renders their opinions upon subjects of this nature entirely conclusive.

"5. This work has conferred many valuable benefits upon science, indirectly and incidentally, in the invention or perfection of instruments, in the improvement of methods of observation or of computation, in the development which it has given to special subjects of interesting inquiry, and in the stimulus which it has furnished to the scientific talent of the country, especially in the field of astronomical observation and investigation.

"6. A careful study of the progress made from year to year, especially since the enlargement of the scale of operations under the present Superintendent, affords ample evidence that the work has been expeditiously prosecuted, and that the amount accomplished up to the present date is materially greater than has ever been accomplished in any other country in the same length of time and with the same means.

"7. Compared with similar surveys executed or in progress of execution by foreign governments, the American Survey has been conducted with remarkable economy.

"8. Compared with such foreign surveys, the quality of the work done in this will bear the test of any standard that has ever been anywhere set up, and is such as to reflect honor on the scientific character of our country in the eyes of the world.

"9. Every consideration of economy, of humanity, and of regard for the reputation of the country, demands that the work should be prosecuted with undiminished activity until every portion of our coast shall have been as thoroughly explored and mapped as those have been already in which its operations commenced.

"10. Conclusive reasons, involving other weighty public interests no less than this, but connected also with the project of verifying in the happiest manner the geodesy of our extended and circuitous coast, conspire to render the triangulation of the great Appalachian chain of mountains a most desirable undertaking, and encourage the hope that our government will very early direct that most important work to be executed.

"11. The publication in full of all the observations upon which the published results of the Coast Survey are founded, together with the methods employed in the reduction and discussion of the observations, would be a contribution to science, and especially to the science of geodesy, of inappreciable value, besides being necessary to secure the records against loss; and the committee earnestly hope that the government may not fail to provide the means for the adequate and rapid prosecution of this work.

"12. The existing organization of the survey, judged in the light of the experience acquired by our own and by foreign governments in the management of such works, is, in the deliberate opinion of the committee, preferable to any other that has ever been suggested.

"These propositions have not been hastily sketched, and are not lightly thrown out; but they are announced as the result of mature reflection and careful consideration. With their

announcement, the duty of the committee, under the resolution appointing them, is discharged. The committee cannot, however, forget that they have another duty, unprescribed by any resolution, to fulfil; which is to express, on behalf of the association which has charged them with their present responsibility and of the world of science, which they may claim for the moment to represent, their deep sense of the obligation which they feel to be due to the enlightened statesmen who, whether in the executive branch of the government or in the legislative halls of Congress, have sustained the work to the present hour by their liberal recommendations or their able advocacy, and have labored to conciliate to it the popular favor by their intelligent and manly expositions of its objects and its value.

"Among the distinguished men who hold in their hands the destinies of the country are still to be found statesmen no less enlightened and no less liberal. To such, therefore, with whatever branch of the government they may be connected, the committee, in conclusion, most cordially commend the important work which they have been reviewing, and, in the name of the associated science of the country, they solicit for it the continuance of the executive favor and legislative support which it has hitherto enjoyed."

TELEGRAPHIC LONGITUDES.

The work of reductions of telegraphic longitudes, under the direction of Doctor B. A. Gould, has made excellent progress, besides which, a working list for a catalogue for selecting proper stars for the latitude determinations of the survey has been carefully prepared. The recent longitude determinations of Calais, Bangor, Mobile, New Orleans, and Albany, New York, are far advanced in their reductions, and it is expected that all the reductions of work of former years will have been completed, and put in the shape for publication before the expiration of another year. A new determination, connecting Apalachicola with the main series, will be undertaken this winter. Careful investigations have been made of the determination of the probable error of reading off the Morse fillets, and of chronographs of different kinds, as well as to a suspected personal equation in reading off the several registers, and the results have been highly satisfactory, as showing the readings made to be affected with smaller mean errors than any other chronograph readings to which the party had access. The personal scale of the readers, too, was tested with satisfactory results, showing the distribution of readings of even the hundredths of seconds to be equable and satisfactory. The special report upon the circumpolar catalogue was published in the Astronomical Journal for January, 1859.

BASE OF VERIFICATION.

The base of verification measured upon Epping plains in Maine, in 1857, has been connected with the primary triangulation, and the verification has been most complete. The approximate length of the measured base, as deduced from the office discussion up to 1859, subject yet to some small change for the full result for the expansion of the comparison bar, and the connexion with the standard metre is 8,715.845 metres. As derived through the primary triangulation from the mean of the Fire island and Providence bases from computations to 1859, the same base is 8,715.837 metres in length, differing but eight millimetres, or three tenths of an inch from the former value.

The verification is much within the corrections to be derived from expansion and comparison with the standard metre.

MAGNETIC OBSERVATIONS.

A memoir prepared by me for the Smithsonian contributions to knowledge and published therein containing a discussion of the magnetic and meteorological observations made between 1840 and 1845, at the Girard College of Philadelphia, under my direction, and the patronage of the American Philosophical Society and of the War Department of the United States, is given in Appendix No. 22. The observations themselves were made in connexion with the extended series under the patronage of the governments of Europe, and were published in extenso by the Senate of the United States. The results are of practical value in connexion with the discussion of changes daily and annual, and others in the magnetic variation, as well as of scientific interest in reference to the periodical character of the disturbances observed. The discussions given in my previous reports have proved useful, in a great variety of cases, to surveyors and others, so that the correspondence in regard to them has at different times been quite interesting, from the number and character of the questions raised and settled. The facts given in this paper will, I feel convinced, find in like manner useful applications in practice.

In a scientific point of view the connexion between a well determined period in the daily variation of the needle and in its disturbances, and the period of change in the solar spots, must be considered not merely curious but important, as proving one of the links connecting the phenomena of the earth's magnetism with the general phenomena of the solar system.

The subject of the secular change of the magnetic declination (variation of the needle) has again been taken up, and the former discussions given in my annual reports for 1855, 1856, and 1858, have been extended. The results are now tabulated and put in a practical form for ready use. Appendix No. 24 presents the report of Assistant Charles A. Schott, on the last results from the discussion of the secular change of the magnetic declination, accompanied by tables showing the declination (variation of the needle) for every tenth year from the date of the earliest reliable observation, for twenty-six stations on the Atlantic, Gulf, and Pacific coasts of the United States. The report, after pointing out the change made in the method of treating the observations adopted since the date of the discussion given in my last report, describes in general outlines the character of the secular change. The formulæ deduced for each station are then presented, accompanied by tables of the declination at every tenth year and the deduced epoch of minimum west (or maximum east) declination with its corresponding amount; and also the annual changes for the three epochs 1840, 1850, and 1860. Results for several stations outside of the limits of the United States are also given. The paper concludes with a list of the observations used in the discussion, but which have not yet been published in either of my former reports.

In the summer Assistant Schott determined the magnetic elements at a number of stations in the New England States, further notices of which will be given under the heads of Section I and Section II, in the body of this report. The results deduced from his observations are stated in tabular form in Appendix No. 23.

A new map of the magnetic variation of the world for 1858, compiled from various authentic sources, has been published under the auspices of the British admiralty, by F. J. Evans, master, R. N. This has been carefully examined by those officers of the Coast Survey whose studies have led them into this field, and meets with high approval. The results have been transferred (Sketch No. 38) to the polyconic projection used in the Coast Survey, and are

given in this report, with a table from the chart, (Appendix No. 16,) showing the variations corresponding to different latitudes and longitudes, for the use of navigators.

GULF STREAM.

The observations in the Florida channel have been completed during the past year, and have yielded the most interesting results, of which a report is given in Appendix No. 25. The form of the bottom of the strait is shown to be simply that of a deep trough, the deepest part of which lies on the Cuban side of the straits. The cold water from the north is found at the bottom of this trough, having a temperature of thirty-four degrees. The overlying warm water of the Gulf Stream is without bands, alternately colder and warmer, as it should be if the figure of the bottom determined the formation of these bands, as has been supposed. At Cape Florida the stream is narrowest and shoalest, and the cold water here comes near to the surface, making this a comparatively cold band in the longitudinal direction of the stream.

The depth of the strait only five miles from Havana is eight hundred fathoms, and close to the island of Bemini three hundred fathoms. This great depth is no doubt caused by the wearing action of the polar current. The form of this trough renders it probable that the main stream of the Gulf is that which makes the circuit of the Gulf of Mexico.

The "cold wall" along the coast of the United States is traceable along the Florida keys and to the Tortugas.

Some investigations, by experiment, of the effect of pressure on the Saxton metallic thermometers are given in the same article of the Appendix.

TIDES AND CURRENTS.

It will be recollected that the physical survey of New York harbor was first commenced at the request of the Commissioners on Harbor Encroachments, and that the expenditures for so much of the work as exceeded the requirements of the Coast Survey have been defrayed by the State of New York, the Coast Survey officers, under authority given to the Commissioners by the President of the United States, and under the directions of the Treasury Department, having carried on the survey. Its results have thus served the double purpose of the new Coast Survey map of the harbor of New York, which in a preliminary form was published in my report of 1857, and which is in progress of engraving in its finished condition, as well as of the Commissioners' map of the harbor.

In regard to the physical survey, it is not too much to claim for the observations made, which have now been continued through several years, that they have developed in a general way the causes of the channels and of the shoals of New York harbor and bar, and of the changes above and below water. The curious and unexpected fact of rotary currents at and below the surface at the entrance to the Hudson, rotating in a vertical direction, so that while the water on the surface is running ebb to the south, below the surface it is running flood, or northward, is fully established by the observations, and is of itself of very great practical value.

About nine thousand observations of currents, of which three thousand were taken below the surface, and seven thousand four hundred and ninety observations of the tides, were made in the course of this work during the past season.

Observations at current stations beyond the light-ship show that the constant currents, independent of those from the drainage of the land waters, sweep the Bay of the Five States. One of these stations was nearly sixty miles east-southeast from Sandy Hook. The motion of these

currents sometimes extends to the whole body of the sea, and at others is more or less superficial. The currents near the south shore of Long Island were observed by casting into the sea large shells previously marked, and noting the places and times at which they were thrown up on the beaches. Nearly one-third of the shells were picked up, and their motion established the existence of an excess of easterly current, independent of the effect of winds and waves. The existence of this easterly drift has often been asserted, and yet the spits of the inlets make to the westward, seeming to disprove the fact of an excess of easterly current. To unravel this many observations were made, and the clue seems to have been found in them, but their full discussion is required before pronouncing upon this. This probable clue is in the movement of the waves.

Appendix No. 26 contains the report of Assistant Mitchell, by whom the observations were made.

RECORDS AND RESULTS.

The inquiries in regard to this publication are constant, notwithstanding the notice given in my last report of the inadequacy of the appropriation to publish the work. The utmost that can be done with the present means is to keep pace with the records in preparing the work, and this imperfectly. A volume of Gulf Stream results will, it is expected, be published within the next year; but if this is accomplished, it is all that can be done, as stated in my last report, with the means in hand from former appropriations. I have no doubt of the importance of resuming this work as soon as the state of the treasury will permit, as it secures the records from possible loss, and enables us, while those are connected with the survey who have executed the work to be published, to have full scientific criticisms of the results. It has been the reproach of such surveys that there is great delay in publishing results, so that they appear only years after the work has ceased, and when the observations are in a degree obsolete. I should like to avoid the application of this remark to our work, if possible.

PROJECTION TABLES.

These tables, as given in Appendix No. 33, were arranged by Assistant J. E. Hilgard, and are the extension to lower latitudes of similar ones which appeared in my annual report for 1856. They are based upon a polyconic development of the earth's surface, which supposes each parallel of latitude to be represented on a plane by the development of a cone, having the parallel for its base, and its vertex in the point where a tangent to the parallel intersects the earth's axis. In this system the degrees on the parallel preserve their true length, and the general distortion of area is less than in any other geometrical mode of representing a given portion of the earth's surface. Bessel's constants, which have been adopted for projections required in the Coast Survey, were used in the formation of the tables.

Table I gives the length in metres of one degree of latitude and longitude for each degree of latitude from 0° to 54°, and the value of the corresponding radius of the developed parallel. It also gives the values of the angle subtended at the vertex of the cone by the developed parallel, for ten degrees of longitude, by means of which the tables may readily be extended.

Table II gives the rectangular co-ordinates for thirty degrees of longitude on each parallel, from latitude 1° to 54°, the numbers in the table corresponding to the actual dimensions of the earth in metres, and only requiring to be divided by the proper number for any desired scale. Notes explanatory of the tables precede them in the Appendix.

INSTRUMENTS AND APPARATUS.

An apparatus for deep-sea soundings, based upon his examinations of this subject, has been devised by Professor W. P. Trowbridge, assistant in the Coast Survey. A full description of the instrument will be found in the Appendix No. 34, and views of its several parts on Sketch No. 39. The principal feature of this sounding apparatus is new, but simple, and it is hoped that a great improvement on the present modes of sounding in great depths may result from its application. The friction upon the line in the descent of the lead is avoided, and the consequent freedom of descent secured by having the line compactly coiled along with the sinker, the uncoiling taking place in the descent of the apparatus. It is proposed to test the practical working of the instrument during the coming season.

The experiments with the pressure tide-gauge of Captain Hunt, of the Corps of Engineers, have been continued, and show that the instrument must in many cases be a very useful one. By filling the tube which communicates between the pressure bag and the indicator with alcohol, we expect to be able to use the instrument at low temperatures and when the surface of the water is covered by ice. The experiments of Mr. J. M. Batchelder, in continuation of those noticed in my report of last year, are stated in Appendix No. 35.

In the report of Assistant Henry Mitchell (Appendix No. 26) will be found descriptions of improvements in apparatus for detecting and measuring sub-currents, and also of an improved form of pile for securing structures upon shoals or along the open coast, where the heavy sea prevents the use of ordinary means. These devices are illustrated in Sketch No. 40.

In the use of the improved current apparatus the velocities of the drifs in the lower water strata are compared with the superficial movements of the sea by measuring, during a specified interval of time, the separation which takes place between a floating body and a system of globes or shafts let down to great depths. When in use the apparatus is in no wise connected with the vessel, so that no discordance in the observations can result from the motions of the latter, and the experiments may be made accurately even in a heavy sea.

Assistant Mitchell's improved pile is a device borrowed from nature, he having observed that certain seed vessels, by virtue of their forms, bury themselves in the earth when agitated by wind or water. This pile, instead of being torn up by the waves, is impelled steadily downward. It may be hewn out ever so roughly, its success in practice depending upon very simple conditions described in the report which I have referred to.

In his past season's operations Mr. Mitchell has made successful use of apparatus comprehending the improvements he describes.

OFFICERS OF THE ARMY.

Between November 1, 1858, and the same date of the present year, five officers of the army have deen detached from the Coast Survey, and two detailed for service. Captain E. B. Hunt, of the Corps of Engineers, has not been regularly detached, but has, in fact, been so occupied with engineering duties as to render it impracticable that he should give any portion of his time to the Coast Survey.

Captain A. H. Seward, U. S. A., detached on his promotion, has rendered good service, and shown remarkable adaptation to our work in charge of a triangulation party in the very difficult region of the inner Florida keys, and the loss of his experience to the survey is much to be regretted.

Lieutenant J. C. Tidball, U. S. A., had been in charge of the drawing division of the Coast Survey for several years, and was a very efficient officer. Lieutenants J. P. Roy, and Rufus Saxton had been serviceable both in the field and office. The experience of all these officers is now lost to us in their several positions.

Appendix No. 3 contains a list of the army officers now attached to the Coast Survey.

OFFICERS OF THE NAVY.

During the past year we have lost by detachment the services of two of the most experienced chiefs of hydrographic parties. Lieutenants T. A. Craven and J. N. Maffitt, U. S. N., have thoroughly indentified their names with the Coast Survey, and wherever their labors have extended, from Maine to Texas, have left the mark of their special ability for the work. During the last period of their service they were but temporarily attached to the survey, it being understood that the Navy Department would soon need them in highly responsible positions connected with the general service, but they, nevertheless, both found time, the former on the Florida reef, in New York harbor, and in the Gulf Stream, and the latter in organizing a system of repairs and equipment, to cause that short period to be remembered as important to the survey.

By the kindness of the Hon. Secretary of the Navy, my letters of acknowledgment to these officers were transmitted to them in the most complimentary way.—(Appendix No. 39.)

Lieutenant W. G. Temple, U. S. N., was detached from the command of the steamer Corwin in October, 1858, and from the survey in April, 1859. He had been in charge of a party less than two years, but his preliminary experience in the work, and his intelligence and industry, rendered every day of his connexion with it useful to the survey.

Lieutenant T. B. Huger, U. S. N., was detached at the close of his summer's work, having earned the name of a zealous and intelligent chief of a hydrographic party.

Of the chiefs of parties who have replaced these officers, Lieutenant Wilkinson and Lieutenant Phelps have had considerable experience in the survey in former years, as junior officers of parties.

The names of all the officers now on duty in the Coast Survey are given in Appendix No. 5.

The deficiency in the number of naval officers, by which only one lieutenant is now allowed to each hydrographic party, has made a radical change in our service. The master's mates allowed to the parties will, in time, be trained to the work, but thus far the difficulties have been much increased by the want of experienced officers. The rules required to give a form of organization to this branch of the service have been adopted, and their working will be carefully observed.

All the engineers of the Coast Survey vessels are now civilians, and their entire emolument is derived from the Coast Survey appropriations. Under the regulations of the Treasury Department they are employed by the chiefs of hydrographic parties at fixed rates of pay, their employment lasting, as a rule, only while the vessels are in commission.

HYDROGRAPHIC DIVISION.

The advantages to be derived from this division have been fully realized by the activity of Lieut. J. N. Maffitt, U. S. N., who was in charge of it at the outset, with Mr. A. Balbach as the draughtsman. Commander S. S. Lee, U. S. N., who has replaced Lieut. Maffitt, will no doubt maintain all its efficiency.

The duties of hydrographic inspector, which are combined with those of the charge of this division, are of great importance, and Commander Lee has already shown the efficiency and economy which must come from the new organization devised by Lieut. Maffitt, and commenced under his immediate supervision.

By the kindness of the Hon. Secretary of the Navy, and of Commodore Smith, chief of the Bureau of Docks and Yards, the necessary store-room has been assigned to us in the New York navy yard, and the order and method introduced into the laying up, repairs, and fitting out of our small vessels, and into the charge of them while laid up, will prove not only a source of efficiency, but also of economy.

AIDS TO NAVIGATION.

As the hydrographic work advances, and developments are made of the known or hitherto unknown dangers to navigation, the practice has been, with the chiefs of parties, to report upon them, with such recommendations in regard to buoys or other marks as in their judgment are necessary. Their remarks on the aids required for safety in navigation are from time to time referred through the department for the consideration of the Light-house Board. Appendix No. 40 contains a list of the cases reported within the year, and Nos. 41, 42, and 43 my communications relative to the special localities and character of the marks required for the purposes of mariners.

OBITUARIES.

The survey has lost during the past year, by death, the services of Lieut. John K. Duer, U. S. N., who was in charge of one of the hydrographic parties in the Gulf of Mexico. This officer discovered in 1857 the new channel east of Dog island, leading into St. George's sound, and to Apalachicola, so important to the future development of that part of the coast of Florida, and was engaged in completing the survey of the approaches when he died. He was a zealous and industrious officer, regarding always the public service rather than his own health or convenience, and died of a disease of the heart aggravated by the labors and responsibilities of his position.

Mr. Gustavus Würdemann, in charge of the tidal observations on the Florida reefs and in the Gulf of Mexico, died at his home in New Jersey on the 29th of September. His health had been failing for some years, and during the last year he had discharged his duties with great difficulty, owing to physical debility.

Mr. Würdemann entered the survey under my predecessor, and served until the period of his death with a fidelity and singleness of purpose that has never been exceeded. Exact truthfulness was the leading trait of his character, and his observations were reliable in the most minute as in the largest points. It is easily seen that it is no exaggeration to say that such a man in his place was invaluable, and an example worthy to be held up as the type of faithfulness. During the discharge of his laborious duties he found time and opportunity to make collections in natural history, which have been acknowledged by the Smithsonian Institution as among its most valuable contributions to the knowledge of the fauna of Florida.

Mr. F. Dankworth, one of the oldest and best engravers in the Coast Survey Office, whose employment dates from 1843, died on the 19th of April. He had been in infirm health for the last year, but continued to the last to work at his art, to which he was successfully devoted.

I proceed now to give, in the usual geographical order, detailed statements of the field-work done on the Atlantic, Gulf, and Pacific coasts of the United States, under the head of sections, the limits of which have been already defined. In each chapter the work is described generally in the natural order taken in its execution, as triangulation, topography, hydrography. Notices of the office-work done in Washington precede the several chapters, each of which corresponds to one of the sections.

SECTION I.

FROM PASSAMAQUODDY BAY TO POINT JUDITH, INCLUDING THE COAST OF THE STATES OF MAINE, NEW HAMPSHIRE, MASSACHUSETTS, AND RHODE ISLAND.—(SKETCH A, NOS. 1 AND 2.)

The progress in the field-work of this section is stated under the following heads:

1. *Geodetic and astronomical observations.*—The primary triangulation and the astronomical and magnetic observations connected with it have been carried to the boundary, and Chamcook station has been occupied for the survey of Passamaquoddy bay.

2. *Triangulation connected with Epping base.*—The primary triangulation has been connected with the base of verification on Epping plains, measured in 1857. The verification from the first approximate computations is highly satisfactory, the length as measured and as computed from the triangulation differing but three-tenths of an inch in five miles and four-tenths. This brings the results much within the range of uncertainties of expansion of measures and the like.

3. *Triangulation of Penobscot bay.*—This work extends over the entrance, embracing the islands as well as the main.

4. *Triangulation of Muscongus bay and sound.*—This work has been extended from the Sheepscot river over the Damariscotta and over Muscongus bay and sound to a junction with the Penobscot work.

5. *Topography of Wiscasset bay.*—A stretch of about four miles above and below the town of Wiscasset has been completed, joining with the work of the previous year on the Sheepscot.

6. *Topography of Merrymeeting bay and of Bath, Maine.*—This is a continuation of the survey of the shores of the Kennebec river.

7. *Topography of Casco bay, Maine.*—This is a continuation of the survey of the main and islands of Casco bay, and extends to Harpswell Neck.

8. Plane-table survey of the Isle of Shoals and adjacent coast.

9. *Topography of Barnstable harbor and approaches, Mass.*—This forms part of the topography of Cape Cod, which remained to be executed on the inner shore.

10. *Hydrography of the approaches to Sheepscot bay and Kennebec river, Maine.*—These were nearly completed. The least depth of water upon "Mile Ledge" was found to be but eighteen feet at mean low tide.

11. *Hydrography of Casco bay.*—This is in continuation of the soundings of the lower part of Casco bay. The well known "Hussey Rock" was found to be erroneously laid down in position on the best charts. The shoal artificially caused off Union wharf, Portland harbor, has been nearly removed.

12. *In-shore hydrography between Cape Elizabeth and Cape Porpoise, coast of Maine.*—This is nearly connected with the hydrography of the approaches to Portland harbor. Cape Porpoise,

Stage Island, and Wood Island harbors were surveyed in connection with this work. The developments here were numerous.

13. *Off-shore hydrography, coast of Maine, New Hampshire, and Massachusetts.*—Important contributions to this have been made.

14. *Examination of Salem harbor.*—This was an extension of the examination of last year.

15. Rock determined in Hyannis harbor, Mass.

16. Magnetic observations at localities extending from Portland to Cape Ann.

17. Tidal observations.

This work has occupied three triangulation and magnetic, four topographical, and two hydrographic parties during the whole or parts of the season.

Office-work.—The drawing and engraving of additions to the chart of Boston harbor have been completed, as also the drawing of those of Portland harbor, Lynn harbor, and a new edition of that of Muskeget channel, and the engraving of the preliminary charts of Kennebec river and Rockport harbor. Progress has been made in the drawing and engraving of general coast chart No. II, from Cape Ann to Gay Head, and of preliminary coast chart No. 3, from Cape Small Point to Cape Cod; in the drawing of coast maps and charts, No. 7, from Muscongus bay to Portland harbor; Nos. 9, 10, and 11, from Cape Neddick to Hyannis harbor, and No. 14, from Cuttyhunk island to Block island; also in the engraving of coast maps and charts, Nos. 12 and 13, from Monomoy to New Bedford; the views for these charts, the finished maps of Kennebec river and Lynn harbor, and the new edition of the chart of Muskeget channel.

Geodetic and astronomical observations.—The party under my immediate direction was organized at Washington early in June for the purpose of completing the primary triangulation of the coast near the northeastern boundary of the United States. The preliminaries required in the erection of additional signals and posting the heliotropers were executed by Assistants C. O. Boutelle and G. W. Dean, and the preparations necessary in occupying the stations were, as usual, made by Mr. Thomas McDonnell, artificer in the Coast Survey.

Station Howard, situated on the western side of Machias bay, and in the township of Machiasport, Washington county, Maine, was first occupied. Owing to unfavorable weather, arising chiefly from the prevalence of sea fogs, but little progress was made until the middle of July, when the measurement of horizontal angles was commenced. From that period the work advanced well, and the various operations being satisfactorily completed by the 15th of August, arrangements were made for the immediate transfer of the party and instruments to the station Western Ridge, in Cooper township, in connection by a primary line, as may be seen by reference to sketch No. 1, with station Howard.

The operations at Howard included the measurement of twenty-four horizontal angles with the thirty-inch theodolite; vertical angles with the eight-inch Gambey circle, C. S. No. 57, upon six points; the determination of the latitude with the zenith telescope; azimuth observations with the thirty-inch theodolite; the determination of the magnetic elements; levellings for ascertaining the height of the station above the sea, and the usual meteorological observations. These several particulars, in connection with others, will presently be noticed more in detail.

The measurements of horizontal angles at station Western Ridge were commenced on the 30th

of August, and the work was pressed forward until the 27th of September, at which date all the geodetic, astronomical, and magnetic observations were brought to a successful close.

For extending the triangulation so as to include the northeastern boundary in the vicinity of Passamaquoddy bay, Chamcook station, near St. Andrew's, New Brunswick, was occupied by Assistant Dean between the 13th and 28th of October, and satisfactory measurements made of the angles required to conclude the primary work.

The facilities extended to Mr. Dean by T. B. Wilson, esq., of Chamcook, and Capt. Thomas Jones, U. S. consul at St. Andrews, while prosecuting the operations in that vicinity, are acknowledged in his report. The following statistics exhibit in brief the work executed by my party in this section during the past season:

Triangulation.—At station Howard 1,066 observations were made with the thirty-inch theodolite, C. S. No. 1, upon ten signals and an elongation mark. The vertical angles for determining the heights of the principal stations were measured with the eight-inch Gambey vertical circle, C. S. No. 57, and for this purpose sixty-seven sets each, consisting of six measurements of the angle, were made upon the signals of six stations.

At Western Ridge station 1,103 observations were made with the large theodolite upon eleven signals and the elongation mark. Nine stations were observed on for the vertical angles, and 560 measurements were made.

At station Chamcook 464 observations were made with the large theodolite upon four signals for horizontal angles. Vertical angles were measured by 234 observations on the same signals with the circle No. 57.

The most distant signal observed on during the season was that on Mt. Desert island, as seen from Western Ridge. This line, between the two stations, is about fifty-eight miles in length. From Western Ridge the highest peak of Mt. Katahdn was observed on incidentally at a distance of about a hundred miles, and with observations of the same kind made at Mt. Desert in 1856, upon the same point, the geographical position of that remarkable feature of the interior of Maine will be approximately determined.

The primary triangulation completed during the season embraces an area of 1,150 square miles.

Latitude and time observations.—At station Howard two hundred and nineteen observations were made with the zenith telescope, C. S. No. 5, upon forty sets of stars. The arc value of a revolution of the micrometer was carefully obtained from one hundred and twenty-two observations on Polaris near its eastern elongation, and the value of a division of the level was found in the usual way by thirty observations upon a collimator with the micrometer.

With the forty-six inch transit, C. S. No. 4, the local time was determined by a hundred and three observations on fifteen standard stars, zenith and circumpolar.

At Western Ridge two hundred and twenty-three observations were made with the zenith telescope upon forty sets of stars. The arc value of the micrometer was ascertained from a hundred and twenty two observations upon the star 51 Hev. Cephei near its eastern elongation, and the customary means were taken for finding the value of the level scale. Local time was determined from seventy-three observations on twenty zenith and circumpolar stars.

The observations for latitude and time were made by Sub-Assistant Edward Goodfellow, aided by Mr. Henry W. Bache.

Azimuth.—The azimuth of the trigonometrical lines at station Howard was determined, as in other cases, with the thirty-inch theodolite, and for that purpose one hundred observations were

made upon Polaris near its eastern elongation, besides seventy-two on Ursæ Minoris, near the upper culmination, in connection with two hundred and eighty observations upon the elongation mark. At Western Ridge the azimuth was determined from seventy observations upon λ Ursæ Minoris, near its upper culmination, and one hundred and twenty-six observations on the elongation mark.

Magnetic observations.—The geological formation at station Howard indicated that the magnet would be affected by local attraction, and the experimental observations made at several points near it proved this to be the case. After selecting the most favorable position, one hundred and forty-seven observations were made for declination, the magnet used being freely suspended during three consecutive days. The inclination was measured with the nine-inch dip-circle, five complete sets of observations being made with two needles. The horizontal intensity and moment of inertia were deduced from two sets of experiments on different days.

At Western Ridge the magnetic declination was ascertained by one hundred and ninety observations on four days, and the inclination from three complete sets made on different days.

At station Chamcook the declination was determined by one hundred and thirty-five observations on three days, the inclination from four sets of experiments on different days, and the horizontal intensity and moment of inertia in the usual way.

Observations were also made at Eastport, Maine, and in its immediate vicinity, for determining the magnetic inclination and local intensity.

The declinometer D. 22, C. S. No. 1, and dip-circle, C. S. No. 4, were used in all the observations made at the several stations.

The azimuth and magnetic observations were made by Assistant Dean, aided by Messrs. R. E. Halter, R. H. Talcott, and C. S. Peirce.

While the astronomical and geodetic operations were in progress at Howard, Mr. Talcott made a series of levellings from the station to a bench-mark which had been established by careful tidal observations made by Mr. McDonnell, who also ran a line of levels between the same points.

Meteorological observations.—The usual journals were kept at the several stations by Mr. Talcott, and in the course of the working season two hundred and ninety readings of the barometer, thermometers, and evaporating point, were recorded.

All the original records were duplicated, and the computations from the latitude, azimuth, and magnetic observations nearly completed, before the party returned from the field. These, making a total of fifty volumes, have been deposited in the archives at Washington.

Assistant Dean and Sub-Assistant Goodfellow are about to resume the prosecution of longitude determinations on the Gulf of Mexico.

Reconnaissance.—The primary triangulation which has been carried through New England having approached the northeastern boundary of the United States, it became desirable that stations should be chosen for closing the series in that quarter so as to include the St. Croix river and Passamaquoddy bay. In the latter part of June Assistant C. O. Boutelle proceeded on this duty, first re-erecting on Mt. Desert island the primary signal which had been destroyed by a storm subsequent to the occupation of that point by my own party in the autumn of 1857, and placing the heliotropes necessary for the measurement of horizontal angles formed at the two remaining stations (Howard and Cooper) west of the boundary, intended to be occupied at a later period in the present surveying year. Ample facilities for the work were afforded in

the use of the U. S. revenue cutter Jackson, by her captain, Joseph Noyes, and by Robert Burns, esq., collector at Eastport, Me., under authority from the Treasury Department.

The official sanction of the colonial authorities of New Brunswick having been received, Mr. Boutelle selected and marked a station at the distance of about a quarter of a mile from the bluff on the north side of Dark harbor, Grand Manan island, and erected a signal at Chamcook, in the vicinity of St. Andrew's. Both of these points (Sketch No. 1) were observed on from the station occupied by my party in September.

The reconnaissance was so made as to settle also the availability of points for the secondary triangulation in the vicinity of Passamaquoddy bay, and for its connection with the primary work. Two signals of the second order were erected—one at Prince Regent's Redoubt, (Moose island,) near Eastport, and the other on Trescott Rock. The positions of these, and the general plan proposed for the smaller triangulation, are shown on Sketch No. 2.

Assistant Boutelle was aided in this service by Mr. C. H. Boyd. In the early part of the surveying year his party was employed in Section V, and afterwards completed the triangulation work, in the vicinity of the Epping base, as will be presently noticed. In the course of the season he visited and examined the lines leading from the two primary stations—Gunstock Mt., in New Hampshire, and Wachusett Mt., in Massachusetts—which had been passed by in the progress of the general triangulation through New England, and which yet remain to be occupied.

Triangulation connected with Epping base.—This duty was commenced on the 17th of September by Assistant Boutelle, from whose report, made on the completion of the work, the following extract is taken:

"In occupying as stations the east and west ends of the base, the theodolite was protected from sun and wind by a temporary structure, and the observing tripods by a couple of screens of light canvas, each of the size of the surrounding scaffold. These were spread on the windward sides, and kept the platform on which the theodolite was placed in perfect steadiness. At the west end of the base the wind blew almost a gale from the northwest on the evening of the 15th and morning of the 16th of October; and although the scaffold was over forty feet high, eighteen feet wide at the base and nine at the top, the protection from the screens was such that the observations were not materially interfered with. It would have been impossible to observe without them, and I consider them a great addition to our means of observing in the southern sections where tripods are more frequently required."

The connection of the base with the primary triangulation was effected by occupying, besides the two ends, the three adjacent stations, namely: Burke, Pigeon Hill, and Tunk Mt., all of which, and also the relative situation of the base line, are shown on Sketch No. 1.

Each of the horizontal angles was determined by a hundred and twenty measurements with the ten-inch Gambey repeating theodolite, C. S. No. 43. The vertical angles were measured by means of the eight-inch Gambey theodolite, C. S. No. 24.

Mr. Boutelle observed a series of consecutive tides near Pigeon Hill, and carried a line of levels to that station, determining its height above the mean level of the sea.

The following summary shows the general statistics of the triangulation:

Stations occupied	5
Signals observed on	36

Angles measured (horizontal)	61
Angles measured (vertical)	33
Number of observations	8,049

The work was completed on the 31st of October.

Assistant Boutelle was aided in the field by Mr. C. H. Boyd. All the records of the work were duplicated before the return of the party from this section. Mr. Boutelle had been previously engaged in Section V.

Triangulation of Penobscot bay, Me.—This work, which was begun last year, has been continued by the party of Sub-Assistant J. A. Sullivan. The stations established by Sub-Assistant Harris were in part occupied, and angular measurements made from them on others above and below the primary line Ragged ——— Isle au Haut, shown on Sketch No. 2. Progress was made in extending the work upwards between the 23d of July and 23d of September, when the schooner Peirce, which attended the party, was despatched for New York. Observations were continued by Mr. Sullivan until the 5th of October.

Sixty points of the third order were determined in position. These and the measurements of secondary angles were made with the Würdemann theodolite, C. S. No. 86.

As every precaution was taken in erecting signals for continuing the triangulation up the bay, there is a fair prospect that the future progress in that direction will be more rapid.

The number of observations made in the course of the season was five thousand one hundred and twenty.

Messrs. R. M. Stiles and J. D. Bradford served with zeal and efficiency as aids in the party.

The previous occupation of Sub-Assistant Sullivan will be referred to under Section VI.

Sub-Assistant Harris, who was last year engaged on Penobscot bay, has sent to the office duplicates of his notes of horizontal angles and descriptions of the signals erected at the outset of the work.

Triangulation over Muscongus bay and sound, Me.—On the 6th of July the party of Sub-Assistant F. P. Webber, commenced the erection of the remaining signals necessary for extending the secondary triangulation eastward of the Sheepscot river, over the Damariscotta river, and over Muscongus bay and sound. The signal at Edgecombe and some others in the vicinity, having been blown down in the spring, were re-erected, and twenty-one others, mostly of the third order, for topographical purposes, were put up. The reconnaissance and preliminaries being complete by the end of July, Mr. Webber, aided by Mr. Julius Kincheloe, commenced the measurement of horizontal and vertical angles, and occupied fifteen stations with the theodolite, at seven of which vertical angles were observed on the signals of the thirty-four stations embraced in his field of work. It will be seen by reference to Sketch No. 2 that the secondary triangulation conducted by Sub-Assistant Webber has been pushed to a connection with that of the lower part of Penobscot bay, on the line which joins Manhegan island with a station on the east side of St. George's river.

Fifty-nine points were determined in position within the scope of the triangulation. The remaining statistics are as follows:

Stations established or re-erected	34
Stations occupied	15
Horizontal angles measured	347
Vertical angles determined	34

Objects observed on	346
Number of observations	3,090

The schooner Hassler, which was used in this service, returned to New York on the 6th of October. In the early part of the surveying year Mr. Webber was engaged in Section V, and is now completing arrangements for returning to the coast of Georgia.

Duplicates of the field-notes made in the triangulation over Damariscotta river and Muscongus bay have been deposited in the office with the descriptions of the signals as now standing.

Topography of Wiscasset bay, Me.—The sheet containing this work was taken into the field by Sub-Assistant W. H. Dennis on the 1st of August. On the south it joins with the work done last year on the Sheepscot river by Assistant Hull Adams. As far as now completed, the topography represents the town of Wiscasset and its environs, and the details found at Edgecombe, on the opposite side of Wiscasset bay, including also the mouth of the Sheepscot, above Wiscasset, making altogether a stretch of about four miles above and below the town. Owing to the nature of the surface the features in detail were found very difficult of delineation.

Sub-Assistant Dennis was efficiently aided in plane table duty by Mr. J. L. Tilghman. Field-work was continued until late in October, with the following result in statistics:

Shore line surveyed	8 miles.
Roads	20 "
Area of minute topography (square miles)	5½

The locality of the work may be seen on Sketch No. 2.

Topography of Merrymeeting bay and Bath, Me.—The supplementary topography required for the chart of the Kennebec river, in the vicinity of Bath, was taken up on the 24th of June by Assistant R. M. Bache. Sub-Assistant W. S. Edwards was attached to his party, and worked with a separate plane-table on the details of the shores of Merrymeeting bay. Assistant Bache traced in the streets and wharves of the city of Bath, which is continuous for about five miles along the west bank of the Kennebec. The very uneven surface represented on the two sheets referred to made the field-work tedious and necessarily slow in execution. The locality is shown on Sketch No. 2. A small portion of the area of each sheet yet remains to be filled in detail.

The following are the statistics of the season:

Shore line surveyed	27 miles.
Wharf line surveyed	7 "
Roads	32 "
Area (square miles)	15

The villages of Woolwich and Winnegand are represented on one of the topographical sheets.

Assistant Bache has inked and sent to the office the plane-table sheet of the Kennebec which was completed last year.

Topography of Casco bay, Me.—The work of the season on the shores of Casco bay, and on the islands east of Portland harbor, was in charge of Assistant A. W. Longfellow, and consisted of filling the interior details and contour of ground of the outstanding sheets, of which the shore line had been previously traced. Assistant A. S. Wadsworth was attached to the plane table party, and Mr. James Gilliss served as aid. The topography was resumed on the 11th of July and continued until the 4th of November. Assistant Longfellow completed the survey of the shores of the Presumpscot river, and of the main shore of Casco bay, from thence north-

ward to a point beyond Sturdivant's island, from which it was extended by Assistant Wadsworth in the same direction abreast of Prince's Point, and there joined to a portion of work also finished by Mr. Longfellow. The topography of the interior of Long's and Cousin's island was completed, as also that of Great Jebeig, Hope, Crotch, and Jewell's islands. The location of the three plane-table sheets worked on, and of which the details are now complete, may be seen in Sketch No. 2. On two other sheets, which embrace Yarmouth river and Harpswell Neck, progress has been made in the shore line survey.

The details of the season's survey are represented in the following statistics:

Shore-line of marshes and ravines	33 miles.
Roads	40 "
Total of contour lines	155 "
Area of topography (square miles)	14

The original sheet containing the topography of Portland harbor, the city and its environs, has been inked and placed with the archives at the office.

The party of Assistant Longfellow used the schooner Meredith for transportation and quarters while working in Casco bay.

Plane-table survey of Saco bay and vicinity, Me.—In order to facilitate the early completion of the charts of soundings to be made between Cape Elizabeth and Kennebunkport, Me., Sub-Assistant C. Fendall was attached to the hydrographic party of Lieut. Comg. Murray, and traced the entire shore-line from Prout's Neck and Stratten island southward, and westward to Kennebunk river. His work, the limits of which, as contained on four plane-table sheets marked on Sketch No. 2, embraces the shores of Saco bay, Wood island, Fletcher's Neck, and all the islands and coast intermediate between the last-named point and Kennebunk river. The Isles of Shoals were also surveyed, and were mapped on a separate topographical sheet.

Topography of Barnstable harbor and vicinity, Mass.—The survey of the shores of Cape Cod bay was commenced on the 7th of July by Assistant A. M. Harrison. Two plane-table sheets were projected—one to include Barnstable harbor, and the other to extend the work westward. The topography was taken up at Scargo Hill, near North Dennis, and in its course westward embraced, besides the usual surface details, the village just named, and also Yarmouth, Yarmouthport, Barnstable, Pond Village, and West Barnstable, together with the Great Marshes in that immediate vicinity, Sandy Neck, and the entire shore of Barnstable harbor. Very few of the details of the vicinity yet remain to be traced on the sheet. Its limits are shown on Sketch No. 2. From the shore line of the harbor the survey was carried back to an average breadth of a mile and a half.

Sub-Assistant P. C. F. West and Mr. A. W. Thompson were attached to the plane-table party, and rendered efficient service.

The character of the country in the vicinity of Barnstable presents almost every variety of ground, and much of it is thickly settled. The Cape Cod railroad is represented in the stretch from West Barnstable to Dennis Pond, where it turns to cross the peninsula.

Assistant Harrison closed work on the 21st of October, but, before leaving the field, visited the triangulation points on which his work was based, reset the station marks, and prepared for the records of the office new sketches of them, accompanied by descriptive notes. The following synopsis of statistics is taken from his report:

Shore-line surveyed	20 miles.
Marsh-line	46½ "
Creeks, ponds, &c.	88½ "
Roads	44½ "
Area of details, (square miles)	15

The plane-table sheet embraces a coast reach of rather more than ten miles, measuring east and west of Barnstable harbor.

Verification of Topography.—After closing special field service, which will be referred to in the following chapter, Assistant H. L. Whiting examined the plane-table work done this season in the vicinity of Wiscasset, and that on the shores and islands of Casco bay and in the neighborhood of Barnstable harbor. The examination was made with reference to the amount and character of the topography, and was fully reported on by Mr. Whiting as being in all respects satisfactory and thorough in detail. The localities mentioned are amongst the most difficult of representation that have yet been passed over by either of the plane-table parties.

Hydrography of the approaches to Sheepscot bay and Kennebec river, Maine.—Under circumstances unusually favorable for work afloat, the hydrography of the approaches to the Sheepscot and Kennebec rivers was completed in August by the party of Lieut. Comg. John Wilkinson, U. S. N., assistant Coast Survey, working with the steamer Corwin. The upper limit of the soundings is on a line passing from Cape Newaggen across and about three miles to seaward of Damiscove island, from whence the work was prosecuted southward and westward to the meridian of Cape Small Point, where it joins the completed hydrography of 1856–'57. The resulting chart will extend several miles to the southward of Seguin island, the soundings in that vicinity being made as supplementary to the hydrography of the Kennebec entrance, executed in the surveying season of 1855–'56. Sketch No. 2 shows the locality and the limits referred to.

The tidal observations required in plotting the soundings were made at a station in Booth bay.

A small sunken rock, known as "Mile Ledge," lying about a mile to the southward of Seguin island light, and which is marked on the old charts as having four fathoms, was found by Lieut. Comg. Wilkinson to have only eighteen feet water at mean low tide. The rock is in the track of vessels bound into Kennebec river, and bears from the light-house S. 9° 30′ E., (true,) or south a little to the westward by compass. The range and other particulars for determining its position were made known to the department in September, in a communication, a copy of which is given in Appendix No. 9.

A summary returned on concluding the hydrography of this vicinity presents the following statistics:

Miles run in sounding	206½
Angles taken	898
Number of soundings	1,971
Area sounded, (square miles)	52

The greatest depth of water found was forty-seven fathoms.

Lieut. Comg. Wilkinson has furnished sailing directions for the chart of the Kennebec river and its approaches.

Within the year the two sheets containing the hydrography of the Sheepscot river, executed by Lieut. Comg. Moore, have been plotted and registered in the office.

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Hydrography of Casco bay, Maine.—The soundings required to complete the hydrography of the lower part of Casco bay were made in the latter part of August and early part of September by the party of Lieut. Comg. Wilkinson, working with the steamer Corwin. A space embracing about twenty square miles abreast of Portland light, and included between Peak's island and Green island, is shown on the chart. Within its limits occurs the Hussey Rock, the position of which has been hitherto erroneously laid down on the best charts of Casco bay, and which, in the course of the operations conducted by Lieut. Comg. Wilkinson, was found to be more than a quarter of a nautical mile northwest of the position heretofore assigned. Bearings and ranges from the true position to fixed points on the main and adjacent islands are given in Appendix No. 10. The Hussey Rock is small and has only twelve feet on it at mean low water. The locality in which the soundings were made may be seen by reference to Sketch No. 2, by which, also, it will be observed that the in-shore hydrography of the section has been pushed as a continuous work as far to the northward and eastward as Cape Newaggen, with the exception of a small interval at Cape Elizabeth, the advance of the season not admitting of a final junction between the lines run by Lieutenant Commanding Wilkinson and those of Lieut. Comg. Murray, the site of whose work will be referred to presently. Tidal observations were made with a staff-gauge at Peak's island while the party was sounding in that vicinity.

At a period since the date of the survey made by Lieutenant Commanding Maxwell Woodhull, U. S. N., the water at one point in the channel off Union wharf, Portland harbor, had shoaled. This was made the subject of examination by Lieut. Comg. Wilkinson, and it appeared that by the sinking of a schooner laden with granite the depth had been for some time decreased. The obstruction is now removed and the depth nearly restored to what it was when the preliminary chart of Portland harbor was first issued.

The following is a summary of the hydrographic statistics:

Miles run in sounding	117½
Angles observed	573
Number of soundings	1,657
Area sounded, (square miles)	20

Having made very favorable progress in the hydrography of the section, the party in the Corwin left Portland on the 2d of October and proceeded to New York.

Lieut. Comg. Wilkinson has turned in the note-books containing the entries of soundings and tidal observations made in Casco bay and in Portland harbor.

The hydrographic sheet showing the soundings made at the entrance of Casco bay by Lieut. Comg. Temple, U. S. N., in the previous surveying season, has also been received.

In-shore hydrography between Cape Elizabeth and Cape Porpoise, coast of Maine.—This work was resumed in July by Lieut. Comg. Alexander Murray, U. S. N., assistant Coast Survey, at last year's limit, near Kennebunkport, and from thence was prosecuted northward and eastward to the vicinity of Cape Elizabeth, the lateness of the season and duty required in the lower part of the section only preventing a junction with hydrography of the approaches to Portland harbor.

Sketch No 36 shows in a general way the present condition of the in-shore soundings on this

part of the coast, and the progress sketch (No. 2) the limits of the several sheets executed this season. The soundings were carried about eight miles out from the coast line and into depths varying between fifty-five and seventy-five fathoms.

Within the limits of this work are several small harbors, with a good depth of water and fine holding ground. Surveys were made of Cape Porpoise, Stage island, and Wood island harbors, and the plotting of the sheet containing them is well advanced.

Sub-Assistant C. Fendall was attached to the party, and furnished plane-table data as needed in the hydrography.

A tide-gauge was set up at Wood island harbor and regular observations referred to a bench-mark were duly recorded as the soundings advanced in that vicinity.

Among the important developments of the present working season on the coast of this section are the following, made by the party of Lieut. Comg. Murray, in the surveying steamer Bibb.

The four-fathom bank off Cape Porpoise, Maine, completely sounded out.

A fishing bank developed off Wood island.

Hussey Rock, off Saco bay, and to the southward of Fletcher's neck, determined in position.—(See Appendix No. 41.)

The position and development of a rock off Ogunquit, bare at low tide, and but very little known.—(See Appendix No. 11.)

Determination of the position of the "Hue and Cry," the "Old Proprietor," and other dangers to navigation off Cape Elizabeth.

The statistics of the in-shore hydrography are as follows:

Miles run in sounding	814
Angles determined by theodolite	75
Angles determined by sextant	2,122
Number of casts of the lead	13,659

The sheets containing the plane-table work done by Sub-Assistant Fendall are now on file with the archives. All the original note-books of soundings and angles and the chart of last year's work have also been deposited in the office.

Being incidentally at Portsmouth harbor, N. H., with the steamer Bibb, Lieut. Comg. Murray rendered acceptable service to another branch of the government at the request of the commandant of the naval station, Captain John Pope, U. S. N., whose acknowledgment of the same will be found in Appendix No. 37.

Mr. W. B. McMurtrie accompanied the hydrographic party, and took views for the charts of the Kennebec entrance, Portland harbor, Stage island harbor, and of several points in the vicinity of Saco bay.

Off-shore hydrography, coast of Maine, New Hampshire, and Massachusetts.—In passing to the upper part of the section in the steamer Bibb, Lieutenant Commanding Murray started from a position eastward of Pollock's Rip light-boat and ran a line of soundings due north to the parallel of Cape Ann, and thence to the Isles of Shoals. From Cape Ann a line was afterwards carried across the southern part of Cashe's Ledge, and as far to the eastward as Seal island, N. S. The greatest depth found on this line was a hundred and sixty fathoms. In crossing Cashe's Ledge the soundings showed a depth of 16 fathoms. From Seal island, N. S., soundings were made on the course to Grand Manan island, and from thence traverse lines were carried

to the westward close in by Mt. Desert Rock and by Matinicus and Manhegan island to Cape Elizabeth.

While in the vicinity of Passamaquoddy bay Lieut. Comg. Murray made a reconnaissance in the waters around Campo Bello and Cross island, and extended soundings on a line from Grand Manan towards the main as far as Sail Rock.

The several courses run in making off-shore soundings are laid down on Sketches Nos. 1 and 2. Saxton's metallic thermometers were used, and gave for depths of a hundred fathoms an average of two and a half degrees in temperature less than that found at the surface. Specimens of the bottom were preserved and the positions from which they were taken duly noted.

A summary of the off-shore statistics is appended.

Miles run	1,175
Soundings	546

Other deep-sea work executed by the party in the steamer Bibb will be mentioned under Section IV.

Lieut. Comg. Wilkinson, in returning southward from this section with the steamer Corwin, carried soundings on a straight course southward from Cape Elizabeth to a position six miles to the eastward of Nausett Centre light (Cape Cod peninsula.) Thirty-two casts were made with the lead, at each of which a specimen of the bottom was brought up. This line is marked on Sketch No. 2.

Examination of Salem harbor, Mass.—The review incidentally made at the close of the last working year being directed to but few points in the harbor, a more extended examination was made by Lieut. Comg. Murray after closing work in the northern part of the section. In reporting the results, that officer says: "All the main features and dangers in the harbor were determined in the original survey, and, with few exceptions, they are properly delineated on the chart of 1855."

Resurvey in Boston harbor.—After completing general hydrographic duty in this section a re-examination was incidentally made by Lieut. Comg. Murray of the upper part of the inner harbor at Boston. Commencing at Mystic river, his observations were continued outwards, and in their course to a point beyond Castle island the following changes were noticed:

A deposit abreast of the timber dock at the navy yard, the soundings showing two feet less of water there than the survey of 1847.

A making out of the flats between Commercial wharf and Bird Island shoals.

A shoal-spit projecting from East Boston, east of the Cunard wharf, and running out into the channel.

The partial wearing of Bird Island shoals.

The extension of the Boston flats towards Bird island.

Referring to a line run from the northeast extremity of Boston flats to the wharf east of Cunard wharf, Lieut. Comg. Murray says: "It is observable that the eighteen-feet curve has been pushed out so far that the channel is contracted at that point nearly one-third, though the depth is retained.

The section from Bird Island flats to Boston flats developed the fact that the channel is moving towards the Bird Island flats, and that those flats are diminishing in size.

Black buoy No. 11, (off Slate Ledge,) which marks the outer edge of the Boston flats, now making towards Bird island, is directly in the mid-channel of 1847, which then had a depth of thirty-four feet. Now the most water found on that line at mean low tide is twenty-five feet, and at the buoy sixteen feet. The channel in that vicinity has become much more serpentine, and great caution is required to prevent the heavier class of vessels from bringing up on the shoal-spits."

A comparison line run from South Boston to Governor's island showed no changes of a marked character as having occurred since the former survey.

Rock in Hyannis harbor, Mass.—The position of a small rock reported by Commander M. Smith, U. S. N., light-house inspector of the second district, as existing not far from the breakwater in Hyannis harbor, and the vicinity of which had been marked by a buoy, was determined by Lieut. Comg. Wilkinson on the passage of the steamer Corwin from New York northward at the outset of the working season in this section. The crest of the rock was found to be about eight feet square, and the depth on it three and a half feet at mean low water, increasing abruptly to twelve feet all around it. From the rock in question Great Rock spindle bears N.NW. ½ W., (true,) or N. by W. ½ W. by compass, and is distant two hundred yards. The ranges for finding its exact position are given in a communication from Lieut. Comg. Wilkinson, which I have placed in the Appendix (No. 12.)

The journals of soundings and tidal observations made in the course of the examination have been sent to the office.

Magnetic observations.—These were made during the month of July by Assistant Charles A. Schott, aided by Mr. J. L. Tilghman. The series extends from Portland to Cape Ann, and includes in all fifteen stations, several of which will be referred to under the head of Section II. In this section the magnetic declination, dip, and intensity were determined at Bowdoin Hill, in Portland, Me.; at Kittery Point, opposite Portsmouth, N. H.; on Plum island, near Newburyport, and at Ipswich, Mass.; also at Beacon Hill station, near Gloucester; at the primary triangulation station, Thompson; at Annis Squam, and at Rockport, on Cape Ann. The five last-named stations were occupied for procuring data to apply to several of the harbor charts of the vicinity, and for adjusting computations of the secular change, as well as for studying local distribution on the peninsula of Cape Ann, the results, so far attained, marking that region as somewhat anomalous with respect to the magnetic elements. Observations were also made at Quebec and Montreal, as additional means for rectifying the charts of isogonic lines, published in 1856.

The instruments used were, for declination and intensity, the magnetometer, by Jones, (C. S. No. 6,) and its attached magnetic theodolite; for dip the Barrow dip circle, (C. S. No. 9;) time was noted on the chronometer (No. 1411) of Parkinson & Frodsham.

The time and azimuth were determined by observing the sun's altitude and azimuth, six sets being made, and three separate observations recorded for each. For declinations the readings were generally continued through a period of three hours at each station. The intensity was ascertained from two trials, each of which gave five independent results from a hundred and fifty vibrations. At three of the stations the deflections were observed to guard against possible accident to the magnet. The observations for dip consisted generally of six sets with the needles No. 1 and No. 2, the polarity being half of the time reversed.

Before setting out and after his return Mr. Schott made, at Washington, full sets of observations for vibration and deflection, in order to determine the magnetic moment of intensity for magnet H. Other instrumental constants were ascertained in the same way, at the station near the Coast Survey office. The index error of the dipping needles used was determined by comparing them with many others.

In the Appendix Nos. 23 and 24 the immediate results obtained by Assistant Schott are given, and their application to questions of great interest as connected with the laws of terrestrial magnetism. The original notes and his computations have been deposited in the archives.

Tidal observations.—The series heretofore referred to as continued at Charlestown, Mass., has been maintained during the past year with great regularity, by means of the self-registering gauge, kept in operation by Mr. T. E. Ready at the U. S. dry dock. Preparations have been made to occupy a permanent tidal station at Eastport, Me.

SECTION II.

FROM POINT JUDITH TO CAPE HENLOPEN, INCLUDING THE COAST OF THE STATES OF CONNECTICUT, NEW YORK, AND NEW JERSEY, AND THE SHORES OF PENNSYLVANIA AND DELAWARE.—(SKETCH B, No. 7.)

The operations in this section have been the following, in continuation of those of former years, and employing one triangulation party, and one double topographical, one magnetic, one tidal and current, and the occasional time of three hydrographic parties:

1. Triangulation of the Hudson river. This has been continued northward so far as to join the preliminary work of 1856 at New Baltimore.
2. Topography of the vicinity of New York, in New York and New Jersey, being in part a continuation of the surveys for the commissioners.
3. Hydrography of the Hudson river, which has been extended to above Poughkeepsie.
4. Resurvey of Hempstead harbor, Long Island sound.
5. Resurvey of the shoal off the Battery, New York harbor.
6. Tides and currents in New York harbor and its approaches.
7. Magnetic observations.
8. Tidal observations.

Office-work.—Progress has been made in the drawing and engraving of coast map and chart No. 22, New York bay and harbor, and in the drawing of the map of Hudson river, from its entrance to Sing Sing. New plates of the middle and eastern sheets of the chart of Long Island sound have been engraved, and the old plate of the chart of Captain's islands, East and West, has been re-engraved.

Triangulation of the Hudson river.—The work of triangulation on this river was resumed at a station a little below Hudson, by Assistant Edmund Blunt, on the 7th of July, and has been extended northward to a junction, at New Baltimore, with the preliminary work done in 1856 between that point and Albany. About fourteen miles of the course of the Hudson falls within the triangulation.

In the vicinity of Yonkers fifteen stations were occupied, and data furnished to the plane-table parties working there under the charge of Assistant Whiting. The progress made in both localities is shown on Sketch No. 7.

Mr. Blunt was assisted in the field by Lieut. W. R. Terrill, U. S. A., and Sub-Assistant G.

H. Bagwell, both of whom had passed the early part of the season on the coast of Florida. Mr. Rufus King, jr., served as aid in the party.

The following is a synopsis from the abstract of the observations turned in by Assistant Blunt on the 15th of October:

Stations occupied	63
Number of observations	9,336
Area of triangulation, (square miles)	151

Mr. Blunt has sent to the office the records of last year's work and descriptions of the signals then observed on.

Topography of South Jamaica; vicinity of Brooklyn and Williamsburg; High Bridge, Yonkers, and Morrisania; and of Hudson City, New Jersey.—The duty of filling in with details several sheets of the survey of Long Island and of the shores of Hudson river in the vicinity of New York city was resumed by Sub-Assistant F. W. Dorr on the 28th of June. Messrs. Cleveland, Rockwell, and McLane Tilton were assigned as aids in the plane-table party. After surveying a small space of the interior, to complete the sheet of the vicinity of Jamaica, Long Island, the party was divided, Mr. Dorr proceeding to Morrisania and finishing a sheet, of which he had executed the principal details in a former season, and Mr. Rockwell taking up the topography of Hudson city, New Jersey, and its environs.

Amongst the additions referred to as made by Sub-Assistant Dorr were surveys of the towns of Morrisania, Melrose, and part of Mott Haven. His party was then transferred to Williamsburg, and until the 1st of October engaged upon the section bounded by Green Point, Williamsburg, and until the 1st of October engaged upon the section bounded by Green Point, Williamsburg, and Brooklyn on the west, joining with the work of the city surveyors; to the east as far as Maspetch, Evergreen cemetery, and East New York; to the Long Island railroad on the south, joining with topography executed by Assistant S. A. Gilbert; and north to the limit of previous work by Assistant H. L. Whiting. The sheets of the locality referred to embrace one of the most thickly settled portions of Long Island, and include the district through which flows Newtown creek and its branches.

Two new wharves, erected since the former survey, at Sands' Point and Great Neck, Long Island Sound, and important as being the landings of steamers during the summer season, were determined in position and laid down by Mr. Dorr on the original sheets.

Under the direction of Sub-Assistant Dorr, Mr. Rockwell, after completing the survey of Hudson City, New Jersey, proceeded to High Bridge and filled in the topography required on the east bank of Harlem river, between that town and Kingsbridge. Part of the Croton aqueduct is represented on the sheet of that quarter. Two sheets of the survey above and below Yonkers were then taken up, and some progress in additional details made on the one extending upwards from the town. The other, which begins half a mile below the village and extends to Spuyten Duyvel creek, including also a stretch of two miles along the Palisades on the west side of the Hudson, was completed by Mr. Rockwell on the 15th of October. Like all the other sheets worked on, the shore line, excepting a portion on one sheet, and some portions of the details, were executed previous to the outset of the present season, the features delineated being required for the finished map of New York harbor.

The following is a summary of the plane-table statistics:

Shore line of Hudson river	6	miles.
Creeks	20½	"
Marsh line	9¾	"
Aqueducts	8½	"
Roads	164	"
Area of details, (square miles)	25	

The early part of the surveying year was employed by Sub-Assistant Dorr in Section VI, and by Mr. Rockwell in Section V.

The care and attention given by Mr. Tilton in chaining for the plane-table survey are especially commended in the report of Sub-Assistant Dorr.

Since the opening of the year the topographical sheets executed by this party in the last working season have been inked and sent to the office.

Mr. Dorr is now preparing to return to Section VI.

Topography of Hudson river, New York.—Two plane-table parties, under the charge of Assistant H. L. Whiting, took the field on the 15th of July, for the purpose of extending the detailed survey required for the finished maps of New York harbor and Hudson river. One of these, conducted by Sub-Assistant N. S. Finney, under the immediate supervision of Mr. Whiting, advanced the work on both sides of the Hudson, from Spuyten Duyvel creek as far upwards as Hastings. The other party, directed by Sub-Assistant John Mechan, completed the topography on both sides of the river between Irvington and Sing Sing on the east, and from Piermont to Rock mountain on the west bank. A portion of the details between Irvington and Hastings yet remains to be filled in. Within the scope of the completed limits the survey includes the villages of Yonkers, Tarrytown, and Upper and Lower Nyack in addition to those before named; the Palisades and the shores of the Tappan Zee.

All the plane-table work executed within the season in the vicinity of New York was verified by Assistant Whiting, and is reported as being thorough in character and accurate in details. In reference to it he says: "Great credit is due to the gentlemen who have been on duty with me, not only during this, but in former seasons, for the zeal and interest manifested and the particular attention given in aiming at and effecting a uniform system and style of work."

From Yonkers north and south to the limits of Mr. Whiting's work, the survey was carried back from the shore of the river to the old post road leading from New York to Albany, which, as being a well defined boundary, yet gives sufficient breadth to include all the characteristic river topography. "On the western shore of the Hudson the only feature presented is the range of the Palisades, which opposite to Yonkers attain the greatest height. The details on that side were carried back sufficiently far to show a fringe of topography uniform in breadth with that of the lower sheets of previous years."

"The character of the work generally is complex and difficult. The details of contour on the eastern shore particularly were very numerous, embracing a range of hills from a hundred and fifty to four hundred feet high, with a great variety of artificial features."

The parties working under the direction of Assistant Whiting closed field operations on the 24th of September. Sub-Assistants Mechan and Finney, who had both been employed in dif-

ferent sections at the south during the former part of the year, then proceeded to make arrangements for resuming duty there.

A synopsis given in the report of Assistant Whiting shows the following details of work done in the vicinity of Yonkers and Tarrytown:

Shore-line surveyed	$22\frac{1}{4}$ miles.
Creeks	12 "
Marsh-line	$4\frac{1}{4}$ "
Roads	99 "

The limits of the plane-table work here noticed may be seen on Sketch No. 7. An area of rather more than eleven square miles is embraced in the survey of the year.

Resurvey of part of Hempstead harbor, Long Island sound.—After returning from the south, Lieut. Comg. T. B. Huger, U. S. N., Assistant Coast Survey, proceeded, in the latter part of August, to determine the position of several rocks within the limits of Hempstead harbor. This duty was performed with the schooner Agassiz, manned by a part of the crew of the steamer Walker. The survey was completed before the end of September, and includes the greater part of the space passed over in the previous examination. The following is an abstract of the statistics recorded in the hydrographic sheet which was turned in at the office shortly after the detachment of Lieut. Comg. Huger from the Coast Survey:

Miles run in sounding	$66\frac{1}{2}$
Angles determined	406
Number of soundings	5,612

The general duty executed by this party will be stated under the head of Section VIII.

Examination of the Battery shoal, New York harbor.—Attention having been invited in reference to the question of a decrease of depth on the Battery shoal, an examination of the vicinity was made by Lieut. Comg. T. A. Craven, U. S. N., Assistant Coast Survey, after his return from duty at the south. The result shows that at a spot off the Emigrant Depot the present depth is only seventeen feet and a half, and that in the angle formed by the line of the battery and pier No. 1 there has been a very rapid filling up. With respect to the changes noticed there, it is added: "The three-fathom curve has been pushed outward eighty yards beyond the line of 1856; the seventeen-feet spot in the outer part of this section is extending towards pier No. 1, and there is an average decrease of three feet in depth throughout that section."

The subject of the changes and their causes are discussed in the report of Lieut. Comg. Craven, which will be found in Appendix No. 13, with my communication to the President of the New York Chamber of Commerce, in transmitting the results of the recent examination.

The action of the Chamber is given in the report of their committee, in the same Appendix.

Hydrography of Hudson river, N. Y.—The sounding of the Hudson was resumed by Lieut. Comg. C. M. Fauntleroy, U. S. N., Assistant Coast Survey, with the schooner Varina, at Newburg, where the work had been discontinued by the party of Lieut. Comg. Moore in a previous season. From thence upwards about fourteen miles and a half, to a point some distance above Poughkeepsie, the entire bed of the river was sounded out between the 1st of August and the close of September. Sketch No. 7 shows the particular stretch referred to. The hydrography of the Hudson is now complete from Poughkeepsie to the bar at Sandy Hook.

Tidal observations were made at three stations simultaneous with the soundings.

The hydrographic statistics are as follows:

Miles run in sounding	$281\frac{1}{2}$
Angles for establishing signals, &c	2,989
Signals established	15
Number of soundings	17,339
Area sounded out (square miles)	$8\frac{1}{2}$

The party in the Varina had been previously engaged in Section V, as will be noticed under the proper head in a subsequent part of this report.

The original sheets of the surveys made of Esopus and Rondout creeks at the close of last year are now at the office.

Tides and currents in New York harbor and its approaches.—This work, which has been going on under my immediate direction for several seasons past, was completed at the end of the summer by Assistant Henry Mitchell, so far as the principal field labors are concerned. It was commenced with the view of ascertaining the causes of certain important changes in the hydrography of the harbor as developed by the comparison of charts of different dates. All the natural forces, such as tides, currents, winds, and waves, which might be supposed to concur in producing the physical effects noticed, were included in the series of observations, and the large amount of information thus obtained will, no doubt, when fully discussed, determine the conditions under which the harbor exists. In my last report reference was made to the discovery of a class of sub-currents the motions of which were found to be quite at variance with those of the surface currents. The observations made during the present season connect these sub-currents with the path of the Hudson in its course through the waters of New York bay, and for their full development it was found necessary to extend the current stations about sixty miles outside of the bar, and also along the coast of Long Island. In the latter vicinity the effect of the land waters was traced quite beyond the reach of the tidal drifts. Observations were made in the same quarter with a view of developing the conditions under which the inlets on the south shore of Long Island are maintained and for ascertaining the causes of their change in position. Thirty-seven current stations were occupied, the records from which contain over eight thousand observations. More than three thousand of the entries are for points below the surface. Appendix No. 26 contains the report of Assistant Mitchell on the season's labors. His report contains remarks on improvements in the apparatus for observing currents at great depths below the surface, and refers also to an improved form of pile for securing tide-gauges on the sea-coast.

Assistant Mitchell was efficiently aided by Mr. W. T. Bright.

The schooner Gallatin was used in the work connected with the physical survey of New York harbor.

All the original note-books and journals kept by Assistant Mitchell while prosecuting the observations on currents have been received and filed in the archives.

Magnetic observations.—In the course of a series of observations at a number of stations in Section I, Assistant C. A. Schott, aided by Mr. J. L. Tilghman, occupied several stations in the interior of New England for ascertaining the secular change, and in order to determine the precise location of the isogonic lines, charts of which were published in 1856.

The declination, dip, and intensity were determined at Hartford, Conn.; at Springfield, Chesterfield, and Deerfield, Mass., and at Rutland, Vt. Details have been given under Section

I in regard to the instruments used at all the stations, and as to the method pursued in observing for the several magnetic elements. The results obtained are set forth at length in the Appendix Nos. 23 and 24. Mr. Schott has deposited his notes and computations in the office.

Tidal observations.—The self-registering tide gauge at Governor's island, New York harbor, has been kept in operation by Mr. R. T. Bassett. Interruptions in the series during the winter were met by observations with an ordinary box-gauge at the Atlantic ferry dock, in Brooklyn.

SECTION III.

FROM CAPE HENLOPEN TO CAPE HENRY, INCLUDING THE COAST OF PART OF THE STATE OF DELAWARE AND THE COAST OF MARYLAND AND PART OF VIRGINIA.—(SKETCH C, No. 9.)

One triangulation, one triangulation and topographical, one topographical and one hydrographic party have been employed in this section.

1. The triangulation of the Potomac river has been continued from the entrance to Britton's bay.

2. Triangulation of Hampton Roads. This has been connected with the main work of the Chesapeake, and a base of verification for the detached triangulation between Richmond and Old Point has been measured.

3. Triangulation and topography of Chincoteague and Sinepuxent bays. This tertiary triangulation was necessary from the scarcity of points furnished by the secondary.

4. A plane-table survey of the Patuxent river, giving merely the shore-line for purposes of the hydrography, and leaving the usual interior work for subsequent filling up, was carried from Holland's Point to Hall's creek.

5. The topography of St. Mary's river was continued to a point about eight miles above its entrance into the Potomac, and St. Inigo's was also included to the distance of about a mile and a half from its mouth.

6. Topography of Milford Haven and Horn and Winter harbors and the vicinity, Chesapeake bay.

7. Shore-line of James river from Coggin's Point to Little Brandon, completing the shore-line and hydrography of the James and Appomattox rivers from Richmond and Petersburg to the mouth of the river on Chesapeake bay.

8. Hydrography of the Patuxent river to Hall's creek.

9. The hydrography of the St. Mary's river was completed, and its approaches and Cornfield harbor sounded.

10. The outstanding hydrography of the James river was also finished this season.

11. The hydrography of Big and Little Annemessex rivers, connecting with the work of Tangier sound, was completed.

12. The tidal observations at Old Point and at the Washington navy yard were continued with the self-registering gauges.

Office-work.—The chart of York river, from King's creek to West Point, has been drawn and engraved. The topography and lettering of coast maps and charts No. 31, Chesapeake bay, from its head to Magothy river, and No. 33, from Hudson river, Md., to the Potomac; of the finished chart of Patapsco river, and the outlines of coast map and chart from Green Run inlet

to Little Machipongo inlet, (from a photographic reduction,) have been engraved. Progress has been made in the drawing and engraving of coast maps and charts Nos. 35 and 36, from Pocomoke sound to the entrance of Chesapeake bay; in the drawing of general coast chart No. IV, from Cape May to Currituck sound; of coast maps and charts Nos. 28 and 29 (the latter mainly by photography) from Cape Henlopen to Little Machipongo inlet; No. 33, Chesapeake bay, the sheet of James river, from Richmond to City Point, and coast map and chart No. 37, from Cape Henry to Currituck sound; and also in the engraving of coast maps and charts No. 32, Chesapeake bay, from Magothy to the Hudson, Md., and No. 34, from the Potomac to Pocomoke sound.

Examination of stations on Chesapeake bay.—The duty of examining the stations of the triangulation, which includes both shores of the Chesapeake bay, was performed in October and November by Assistant G. D. Wise, who commenced at the head of the bay, and visited all but a few in the series connected with the work done in its lower part.

"The stations were found in much better preservation on the low lands of the eastern shore than on the higher lands of the western. Lieut. Seward, who examined them in 1854, had marked them so securely that in no case had the marks been removed except from natural causes."

Mr. Wise used the schooner Howell Cobb in this service. He has turned in sketches of the stations, and full descriptions and references to guide in finding the marks in future. The duty conducted under his direction in the former part of the surveying season will be stated under the head of Section VII.

Triangulation of the Potomac river, Va.—The stations necessary for extending the triangulation of the Potomac upwards, from the mouth of the St. Mary's to Britton's bay, were selected by Assistant John Farley in the latter part of October, 1858. His party used the schooner Guthrie in that service for transportation. Frequent storms retarded the general operations, and the observations with the theodolite were also much hindered by unfavorable weather.

This triangulation, as may be seen on Sketch No. 9, stretches up the Potomac to Tower Hill, a distance of about nine miles from the station occupied last year on George's island. On the lower side of the river three stations were occupied at the mouth of its branch known as the Yeocomico.

Mr. Farley was assisted in the field by Sub-Assistant S. A. Wainwright.

An abstract from the records gives the following summary of statistics:

Stations occupied	10
Angles measured	24
Number of observations	696

Assistant Farley was employed until the 20th of December in the measurement of angles, and used for that purpose the six-inch Gambey theodolite, C. S. No. 76. As the work advanced he furnished points additional to those determined in 1857 for the plane-table survey of the St. Mary's river. An area of about thirty-seven square miles is comprised within the limits of the season's work on the Potomac.

The occupation of the party at a subsequent period of the surveying year will be stated under the next head in this chapter.

During the intervals between the seasons for field duties the computations of the triangu-

lation were kept in hand by Mr. Farley and completed. These, with an abstract of the results and duplicates of the records of horizontal angles, are now in the office.

Triangulation of Hampton Roads, Va.—The triangulation, which has advanced steadily downwards from City Point towards the mouth of the James river, has been connected with the main work on Chesapeake bay by a series of triangles carried over Hampton Roads by Assistant Farley. The junction was made on the line, Old Point Comfort—Willoughby, at the entrance of the river, as shown on Sketch No. 9.

For the purpose of verifying the entire triangulation between Richmond, Va., and Old Point Comfort, a base was measured in May at a point on the north side, and about fifty miles above the mouth of the James river. One of the intermediate stations used in the triangulation corresponds with a terminus of the base, and both termini were connected with the station at Claremont, on the south side of the river.—(See Sketch.)

The computations resulting from the data for the verification of the work are now in progress.

The triangulation and operations connected with the measurement of the base near Claremont occupied the party until the 22d of June. The schooner John Y. Mason, which had been employed in the work, then returned to Baltimore. Sub-Assistant Wainwright assisted Mr. Farley in the several localities in which his party was engaged in this section.

The following synopsis refers to the duty performed this season in completing the triangulation of the James river:

Stations occupied	10
Angles determined	16
Number of observations	700

The record of horizontal angles, notes kept during the measurement of the verification base, and descriptions of the signals used this season, have been furnished by Assistant Farley.

Triangulation and topography of Chincoteague and Sinepuxent bays, Md. and Va.—As a basis of the plane-table survey north of Chincoteague inlet, Sub-Assistant Charles Ferguson made, in the latter part of June, a careful reconnaissance and tertiary triangulation between Snead Signal (Sketch No. 9) and Robbins's Point, on the main coast of Maryland. The two stations Hardy and Snead, erected in the secondary triangulation of 1849, being found undisturbed in position, were reoccupied, and six others chosen for connecting Assateague island with the coast. In the selection of the sites full attention was given to the requirements of the topography, and also to the means for rendering the stations permanent, for purposes of future reference.

This triangulation extends about twenty-one miles north and east from Chincoteague inlet. Exclusive of the stations occupied with the theodolite, five points were determined in position for plane-table reference. The statistics of the triangulation are as follows:

Stations occupied	8
Angles measured	24
Number of observations	1,100

Mr. Ferguson used in this work the six-inch Brunner theodolite, C. S. No. 66. His computations and original notes of the field-work have been received.

The topography was resumed at the limit reached last year on the 20th of July. The portion executed between that date and the 16th of September includes the mainland or western side

of Chincoteague bay, from Long Point north to "Deserted House," the details consisting principally of farm land and forest, intersected by numerous small creeks, and a broad belt of marsh along the line of the shore. The same sheet embraces the whole of Assateague island, with the Ragged Point island marshes; Pope's bay and its marsh islands; and Pine island, situated in New Inlet; together with the seabeach from Assateague bay to Ragged Point. The general features of the main and islands in this vicinity are shown on Sketch No. 9.

A synopsis taken from the completed sheet gives the following statistics of work done this season:

Shore-line surveyed	45	miles.
Roads	16	"
Creeks	26	"
Area, (square miles)	19	

Sub-Assistant Ferguson had been previously employed in Section VI. The schooner Dana was used in the triangulation and topography of Chincoteague bay.

In the course of the season the plane-table sheet of Chincoteague island and vicinity, surveyed last year, was inked and sent to the office.

Plane-table survey of the Patuxent river, Md.—As a basis for completing the supplementary soundings required in the Patuxent, Assistant I. Hull Adams started on the 19th of April, at Holland's Point, and traced both shores of that river northward to Hall's creek, using points furnished by the triangulation of Lieut. J. P. Roy, U. S. A. The mouths and lower portions of Swanston creek and Hunting creek were included in the working sheet, on which were also marked the steamboat landings at Benedict, Trueman's Point, Holland's cliff, Magruder's Ferry, and Lower Marlboro'. About fourteen miles of the course of the Patuxent (Sketch No. 9) are represented on the map of this season. The length of shore-line traced and furnished to the hydrographic party is about thirty-seven miles.

This service was completed by the 16th of May, when the plane-table party in the schooner Dana was transferred for similar duty to the James river, Va. The stations used in the triangulation of the Patuxent were visited by Assistant Adams, and found in good preservation.

Topography of St. Mary's river, Md.—This work was begun by Assistant Adams on the 17th of November, 1858, and prosecuted until the end of that year. The limit reached corresponds to the upper line of the plane-table sheet marked on Sketch No. 9. Both shores of the river were traced upward, the eastern from Ket's Point, and the opposite side from the southern shore of George's island, respectively, to Milborne's wharf. This point is nearly eight miles above the entrance into the Potomac. About four miles above its mouth the St. Mary's river receives from the eastward St. Inigo's creek, the course of which was traced by Mr. Adams to the distance of a mile and a half. The shores of Carthagena creek, emptying in on the western side, were also defined for some distance. The shore-line traced on the working sheet makes an aggregate of thirty-eight miles within an area of about twenty-eight square miles.

This survey is based on the triangulation executed by Assistant John Farley in 1857.

Assistant Adams was aided in the plane-table work by Mr. J. G. Macawley. Progress in the field was much hindered by heavy rains, fogs, and gales of wind.

The sounding of the lower part of the St. Mary's was executed in the latter part of the

surveying season of 1857–'58, as stated in my last annual report. Sketch No. 14, accompanying this report, shows the result of the labors of the field and by hydrographic parties.

Mr. Adams discontinued work on the 5th of January, and proceeded to Baltimore in the schooner John Y. Mason, which had been in the service of his party on the St. Mary's. The vessel was soon after transferred to the party of Assistant Farley and employed in the triangulation of Hampton Roads, as already stated.

Assistant Adams is now preparing to return and fill in the details required for a finished map of the St. Mary's.

Topography of Milford haven, and Horn and Winter harbors and vicinity, Chesapeake bay, Va.—The survey of the western shore of the Chesapeake, between Rappahannock river and York river, was resumed by Assistant John Seib on the 15th of August, with a party in the schooner John Y. Mason. Two sheets, connecting at the Wolf Trap, will contain the detailed topography of the Piankatank river, Hill's bay, Milford haven, Haven creek and its branches, Garden creek, Horn harbor, Winter harbor, Mobjack bay, with East, North, Ware, and Severn rivers, and the western shore of Chesapeake bay from Cherry Point southward to New Point Comfort. In most of these localities the plane-table work was completed by the end of October, leaving only the three last-named rivers and Hill's bay for survey in the next year. The limits of both sheets are marked on Sketch No. 9. When these are completed, there will remain outstanding only a few small detached portions of topography on the shores of the Chesapeake, which can be readily finished without applying the entire working season of the party which has been heretofore employed on it.

Reference will be made under Section V to the previous occupation of Mr. Seib.

The inking of the two sheets of the Chesapeake shore was kept in progress when the weather would not admit of working in the field.

A summary given in the report of Assistant Seib shows the following progress by his party in this section:

Shore-line surveyed	$74\frac{1}{2}$	miles.
Roads	23	"
Area, (square miles)	20	

The character of the topography is even in surface and interspersed with woods and numerous water-courses over a thickly-settled district.

On closing work the schooner Mason was transferred to the charge of Assistant John Farley, for use in the triangulation of the Potomac river.

The upper sheet of York river, which was inked within the season, is now on file in the archives.

Shore-line survey of James river, Va.—On closing the last plane-table operations on this river, the shores of a stretch extending about five miles between Coggin's Point and Little Brandon yet remained to be traced in order to complete the preliminary survey. This duty was executed in the latter part of May and early part of the following month, by Assistant Adams, after closing work on the Patuxent, to which reference has already been made.

The entire course of the James river, from its entrance upward to City Point, has now been traced, and the shores of its two branches above, to Richmond on the main stream and to Petersburg on the Appomattox. The stretch represented on the sheet of this season (Sketch

No. 9) commences about seven miles below City Point. It contains twenty-four and a half miles of shore-line within an area of sixteen square miles.

The schooner Dana, which was used by Assistant Adams in this work, returned to Baltimore by the 14th of June, and was then assigned for similar service to the party of Sub-Assistant C. Ferguson.

Hydrography of the Patuxent river, Md.—The soundings required to complete the chart of this river were made towards the close of May, by the party of Commander W. T. Muse, U. S. N., Assistant Coast Survey, working with the boats of the steamer Hetzel. From the limit reached last season, as marked on Sketch No. 9, the work was extended upwards to Hall's creek, within the triangulation made by Lieut. J. P. Roy, U. S. A., shore-line being furnished at the same time by Assistant Adams. The statistics of the supplementary hydrography are as follows:

Miles run in sounding	88½
Angles determined	274
Number of casts of the lead	7,554

Hydrography of the St. Mary's river, Md.—The lower part of the St. Mary's river, Md., was sounded out in the latter part of the working season of 1856–'57, by the party of Commander Muse, in advance of the triangulation, which was not taken up until the following spring. Before resuming the work, with a view of extending the soundings upward so as to complete a chart of the river, some discrepancies being noticed in the determination of the positions of signals used in the two operations, the hydrography was verified by new lines traversing the former work. Supplementary soundings were also made below the mouth of the river, and in the channel of the Potomac between it and Point Lookout, so as to include the small cove known as Cornfield harbor. The locality and its connection with the Chesapeake are shown on Sketch No. 9. A reduction from the hydrographic sheet, which has been turned in, accompanies this report as a preliminary chart, and is marked as Sketch No. 14.

The following are statistics of the soundings made this year in the St. Mary's and vicinity:

Miles run	318
Angles taken	653
Number of soundings	15,868

The hydrography was executed with the steamer Hetzel in the latter part of August and early part of September.

In regard to the capacity of the St. Mary's as a harbor, the following remarks made by Commander Muse in his report on the work done in 1857 are again quoted: "The largest vessels can enter the St. Mary's river with ease, and be well protected. Its short distance from Chesapeake bay would enable vessels to leave in the severest winters, while others remain blocked in ice at most of our large cities. At convenient distances the river is indented by bays, which admit of vessels remaining at anchor to load and unload without interfering with the main channel."

Hydrography of James river, Va.—A portion of the James river, below City Point, which had not been reached in the progress of the hydrography upward, was sounded out in August by the party of Commander Muse. The space referred to is comprised between Coggin's Point and Little Brandon, (Sketch No. 9,) and embraces a reach of about seven miles.

This work completes the hydrography from Richmond to the entrance in Chesapeake bay.

The shore-line necessary for the soundings was furnished by Assistant Adams.

A summary of the hydrographic statistics is appended:

Miles run in sounding	83¼
Angles measured	301
Casts of the lead	5,940

The sheet containing this work is now at the office.

Hydrography of Big Annemessex and Little Annemessex rivers, Md.—The supplementary soundings required for the engraved sheet of Chesapeake bay, which will contain Tangier sound and its branches, were made by the party of Commander Muse in September. This work (Sketch No. 9) includes the Big Annemessex and Little Annemessex rivers, and connects with the general hydrography of the sound, executed by the party of Lieut. Comg. J. J. Almy, in 1856.

All of the principal and very nearly all of the minor hydrographic details necessary for the finished chart of Chesapeake bay are now complete.

A synopsis given by Commander Muse at the end of the season shows the statistics of work in the Big and Little Annemessex, as follows:

Miles run	91½
Angles taken	272
Soundings	6,947

The steamer Hetzel was used for this and other duty performed in the same section by the party of Commander Muse.

Tidal observations.—The self-registering tide-gauge at Old Point Comfort has been continued in operation under the charge of Mr. M. C. King. A similar gauge has been used in keeping up the series of observations commenced last year at the Washington navy yard. The attention necessary in maintaining regular observations with it was given in part by officers attached to the ordnance department of the yard, under the direction of Commander Dahlgren.

SECTION IV.

FROM CAPE HENRY TO CAPE FEAR, INCLUDING PART OF THE COAST OF THE STATES OF VIRGINIA AND NORTH CAROLINA.—(SKETCH D, No. 15.)

The primary triangulation of Pamplico sound has been resumed in this section; work of verification in the neighborhood of the Cape Fear has been done; the topography between Cape Henry and Currituck sound has been completed; in-shore hydrography of the coast near Bogue and New River inlets has been executed, and off-shore work between Cape Lookout and Cape Fear. Notices of these several operations are given in this chapter.

Office-work.—Comparative charts of the Cape Fear entrances, showing the changes from 1851 to 1858, and diagrams illustrating Gulf Stream explorations, have been drawn, and the former engraved upon stone under the direction of the Superintendent of Public Printing. Progress has been made in the drawing and engraving of preliminary coast chart No. 11, from Cape Hatteras to Cape Lookout; in the drawing of No. 12, from Cape Lookout to Cape Fear; in that of coast map and chart No. 48, from Bogue inlet to Barren inlet; and in the engraving of coast maps and charts Nos. 40 and 41, Albemarle sound.

Triangulation of Pamplico sound, N. C.—The preliminaries necessary for the primary triangulation of Pamplico sound were commenced early in January by Captain T. J. Cram, U. S.

Top. Engineers, Assistant Coast Survey, his party having sailed from Baltimore on the 27th of December, with the requisite equipage, in the schooner Bancroft.

Such general facts as had been gathered in the reconnaissance made by Major Prince, U. S. A., in 1851, were applied by Captain Cram, who proceeded to develop from them a scheme for working, by the minute examination of points chosen with reference to their availability for the purposes of triangulation, as well as for proper connections with the main coast series to the northward and southward. To that end stations at the upper part of the sound, connecting with the base on Bodie's island, were selected, and signals prepared for them of the kind required in the measurement of primary angles.

These points, and others at proper intervals on both shores of the sound, are marked on Sketch No. 15, which shows the plan as finally adopted for the triangulation. Some of the tripods and signals necessary for observing with the theodolite were erected, and for those which were not set up materials were prepared and fitted by the party before closing for the season.

Five stations of the first order were erected in the course of the season, and seventeen points in all chosen by preliminary measurements. The party discontinued work on the 12th of April, and is now reorganizing under the direction of Capt. Cram for resuming and prosecuting the triangulation during the coming winter and the spring following.

Verification of triangles in the vicinity of Cape Fear, N. C.—The revision of the system of small triangles laid out on the coast of North Carolina was resumed by Assistant A. S. Wadsworth on the 10th of November, 1858, at a station about five miles north of Federal Point. Most of the signals which had been used between it and Smithville having been lost, as well as the marks at the north and south ends of the base on Smith's island, (Cape Fear,) others were established, and a new triangulation made across the mouth of Cape Fear river. The scheme of triangles as remeasured may be seen on Sketch No. 15.

For the purpose of verification a new base site was selected, corresponding as nearly as possible to the line measured on Smith's island, with the additional advantage that the ends are coincident with two stations used in making the triangulation from Federal Point southward in 1851. "The site passes over a level beach, and is as permanent in character as any available line can be in that vicinity. At any state of the tide the north end is easily accessible in boats."

In order to test the geodetic value of the small coast triangulation, steps will be taken as early as practicable for the measurement of the base of verification. The ends were connected with the triangulation of this season at the stations at Fort Johnston (Smithville) and Fort Caswell, as shown on the progress sketch, (No. 15.)

Assistant Wadsworth closed work on the 7th of April, and reported at the office in Washington, where he made the resulting computations and duplicated his record of angles. In the field-work he used the six-inch Brunner theodolite C. S. No. 59. The following summary is taken from his report on the triangulation:

Stations occupied	12
Signals observed on	12
Angles measured	30
Number of observations	1,191

The latter part of the season was more than usually unfavorable for field-work in the vicinity of Cape Fear.

In July Mr. Wadsworth proceeded to Section I, and engaged in the topography of Casco bay.

Topography between Cape Henry, Va., and Currituck sound, N. C.—The entire outer coast line of Virginia, and the region immediately adjacent to it, from Cape Henry and Lynn Haven bay southward to the boundary line, in connection with the district comprising the upper part of Currituck sound, have been passed over with the plane-table by Sub-Assistant John Mechan, and the details included within the limits referred to have been completed. On the outer coast of North Carolina the work of this season was extended to a junction, at Fresh Pond Hill, with surveys made in previous years by the late Assistant J. J. S. Hassler, mention of whose death was made in my last annual report. The point referred to lies about thirty-one miles below Cape Henry. The upper shores of Currituck sound, the eastern shore of Knott's island, and the western side of Back bay, had been traced by Mr. Hassler, who also executed some detached portions of topography while prosecuting the triangulation in the direction of Cape Henry.

Sub-Assistant Mechan took the field on the 25th of November, and was aided during the season by Mr. F. R. Hassler. Bad weather prevailed generally while the party was at work; but by employing the unfavorable intervals in chaining and in ordinary plane-table determinations, the details of four topographical sheets were filled in by the end of May, completing the survey between Albemarle sound and Cape Henry. In going southward from Chesapeake bay, the work of this season embraces the continuous shores of Lynn Haven river and inlet, Long creek, Broad bay, and Linkhorn bay, which separates the desert of Cape Henry from the interior. To the southward was traversed a closely-settled belt of coast, broken only by Rudy inlet, which is about seven miles from Cape Henry light-house. Lower down, North bay, and, in connection with it, the eastern shore and the islands of Back bay, were surveyed, as also Knott's island and Mackay's island, in the upper part of Currituck sound. On the sheet containing the survey of Back bay is represented a feature of the outer coast which has been often mistaken for Cape Henry when seen from vessels approaching the land. Its position, as well as the limits of the several sheets now under notice, are marked on Sketch No. 15. The following remarks are made in reference to this vicinity in the report of Mr. Mechan: "Back bay is divided from the ocean on the east by a sand beach, the southern extremity of which is dotted with high sand dunes, and oak, pine, and cedar hummocks, containing the huts of numerous wreckers and fishermen, and known as the 'Wash Woods.' Further north are the 'Wash Flats,' a low smooth strand, so near the general level of the sea as to be submerged during strong easterly gales. When viewed from a vessel at sea, it seems a continuation of the ocean, and, with the high sand-hill range and trees of the 'Wash Woods,' presents so near a resemblance to the entrance of the Chesapeake at Cape Henry as to have been often taken for it, with disastrous effects; hence it is called 'False Cape,' or the 'False Cape of the Chesapeake.' The sand dunes at Cape Henry are in some places eighty-five feet above the ocean level."

From the upper part of Currituck sound, the plane-table work was extended northward to a point two miles above Pungo bridge, so as to include the shores of North river, an important

link in the line of inland navigation, which now connects Chesapeake bay with Albemarle sound.

The progress made by the topographical party is shown in the following abstract of statistics:

Coast-line (ocean) surveyed	31	miles.
Shore-line of bays, islands, &c.	169½	"
Roads surveyed	116	"
Area of sheets, (square miles)	157	

On his return from this section, Sub-Assistant Mechan was assigned to duty in the vicinity of New York city. In the course of the summer the sheets of the region between Cape Henry and Currituck were inked and sent to the office.

Hydrographic.—Office-work.—Two sheets containing the soundings executed during the surveying year 1857–'58, in Pamplico sound, have been received from Commander W. T. Muse, U. S. N., and registered in the archives.

In-shore hydrography between Bogue inlet and New River inlet, coast of North Carolina.—In continuation of the hydrography extending from Cape Lookout towards Cape Fear work was resumed on the 6th of April by Lieut. Comg. Alex'r Murray, U. S. N., assistant Coast Survey, at Bogue inlet, and carried down the coast of North Carolina at favorable intervals between that date and the 1st of June. A stretch of about thirteen miles coastwise, terminating as shown on Sketch No. 15 at New River inlet, was traversed by lines parallel to the shore and crossed by others going off to an average distance of ten miles from the land. This duty was executed in the surveying steamer Bibb. The following synopsis of statistics was returned by Lieut. Comg. Murray at the end of the season:

Miles run in sounding	232
Angles determined	714
Number of soundings	3,262

Off-shore soundings, from Cape Lookout, N. C.—While prosecuting the in-shore hydrography with the steamer Bibb, Lieut. Comg. Murray, ran, at favorable intervals, several lines to the northward of Cape Hatteras and others between Cape Lookout and Cape Fear, in order to furnish data for filling the project of the general coast chart No. V.

At the termination of a line carried broad off between Cape Hatteras and Cape Lookout a specimen of bottom was brought up in the axis of the Gulf Stream, the Massey sounding apparatus, used in that instance, indicating a depth of 2,059 fathoms. The material found was grayish mud or clay.

In reference to the current underrunning the Gulf Stream, Lieut. Comg. Murray remarks: "The wind was N.E. and light; the steamer lay with her head to the southward and eastward, and the line went from the stern, tending to the northward, but upon reeling it up we discovered that an undercurrent had carried it to the southward. This occurred twice under similar circumstances."

The statistics of the off-shore work are as follows:

Miles run in sounding	1,235
Casts of the lead	3,318

In the course of the season three hydrographic sheets, one containing the work done in 1857–'58, and two the soundings made this year, have been plotted and turned in at the office with the records of soundings, angles, and tidal observations.

The party in the steamer Bibb, after its return from this section, refitted at New York and passed the remainder of the season in prosecuting the general hydrography of Section I.

SECTION V.

FROM CAPE FEAR TO ST. MARY'S RIVER, INCLUDING PART OF THE COAST OF NORTH CAROLINA, AND THE COAST OF SOUTH CAROLINA AND GEORGIA.—(SKETCH E, No. 16.)

The usual number of parties has been employed in this section, namely: one in making astronomical and magnetic observations, one in primary and secondary triangulation and in astronomical and magnetic observations, one in secondary triangulation, one in secondary triangulation and topography, two in topography, and two in hydrography. The work accomplished is stated under the following heads:

1. Astronomical and magnetic observations near Cape Fear entrance.
2. Triangulation and topography westward of Tubbs' inlet, N. C.
3. Astronomical and magnetic observations at St. Helena island, S. C.
4. Primary triangulation, coast of South Carolina.
5. Triangulation of Beaufort, Chechessee, and Colleton rivers, S. C.
6. Triangulation of Doboy and Altamaha sounds, Ga.
7. Shore-line survey from St. Helena sound, S. C., to Savannah river entrance.
8. Topography of St. Catherine's sound, Ga.
9. In-shore hydrography from Cape Fear westward to Tubbs' inlet, N. C.
10. Off-shore hydrography from Cape Fear to Charleston harbor.
11. Hydrography of Bull's bay, S. C.
12. Hydrography of Port Royal entrance, S. C.
13. Hydrography of the Chechessee and Colleton rivers, S. C.
14. Hydrography of Sapelo bar and its approaches, Ga.
15. Tidal observations.

Office-work.—In the drawing and engraving divisions, additions have been made to the chart of Charleston harbor. The chart of Sapelo sound has been drawn and engraved and the engraving of preliminary coast chart No. 14, from Cape Romain to Savannah, has been in hand. Progress has been made in the drawing of coast maps and charts No. 53, from Charleston harbor to St. Helena sound, and No. 58, from St. Mary's river to the St. John's, Fla., and in that of the chart of Ossabaw sound.

Latitude observations at Smithville, N. C.—The adjustment of the triangulation on the coast of North Carolina requiring that the latitude of a point in the vicinity of Cape Fear should be closely determined, as well as the azimuth, an astronomical party was organized on the 1st of April, under my immediate direction, and placed in charge of Assistant G. W. Dean. A station was erected at Fort Johnson, Smithville, N. C., and the necessary preliminaries for astronomical work were arranged by Mr. Thomas McDonnell. Sub-Assistant Edward Goodfellow was detailed to assist in the observations. Those for the latitude and time were made by him with the zenith telescope C. S. No. 5, and forty-six-inch transit C. S. No. 4. With the first-mentioned instrument twenty-nine pairs of stars were observed by one hundred and seventy-four sets of observations. Fourteen standard stars were observed on with the transit, and ninety-six observations recorded. The value of the micrometer threads was ascertained by one hundred and twenty-two observations on the star 51 *Cephei*, near its western elongation. Forty-six observations were made with the micrometer upon a collimator adjusted to a stellar

focus, for determining the arc value of graduations on the level of the zenith telescope, and the corresponding divisions of the transit instrument were tested by comparisons with it.

As far as practicable, the stars observed for latitude were taken from the Greenwich Twelve Year Catalogue, the sets, as heretofore, being completed from that of the British Association. Mr. W. H. Odenheimer aided Sub-Assistant Goodfellow, and recorded the observations. Unusually good weather prevailing during the stay of the party, all the requisite determinations were completed by the 7th of May.

Azimuth.—The azimuth for the lines of the triangulation was determined by Assistant Dean. For that purpose nine sets of observations were made with the twenty-four-inch theodolite (C. S. No. 2) on *Polaris* at its lower culmination, and six sets on *δ Ursae Minoris* near its eastern elongation. In each series six pointings were made on the star with the telescope direct, and the same number with the instruments reversed. An elongation mark was set up and connected in the usual way with the triangulation, twelve sets of pointings being made on it with the telescope direct and reversed. The mark was referred to three geodetic signals by four hundred and thirty-six observations made at six different periods, each embracing the observations of an entire day. In making them the circle of the instrument was used in five different positions. The azimuth observations were recorded by Mr. McLane Tilton.

Magnetic observations at Smithville, N. C.—For the declination of the needle at the astronomical station (Fort Johnson) one hundred and forty-seven observations were made on three days by Assistant Dean and Sub-Assistant Goodfellow. Four sets were made on three days for the magnetic dip, and two sets on two days for the horizontal intensity and moment of inertia. The instruments used were declinometer D. 22 (C. S. No. 1) and the nine-inch dip circle C. S. No. 4.

The usual meteorological journal was kept by Mr. Tilton, while the observations were going on for latitude, azimuth, and the magnetic elements.

Immediately after the return of the party the records kept at the astronomical station were duplicated by Sub-Assistant Goodfellow and placed in the archives, with his computation for latitude, with that of Mr. Dean for azimuth, and lists of the stars used in observing for latitude.

In June the party was transferred to Section I, and remained until the close of the season under my personal direction, as stated in a previous chapter of this report.

Triangulation and topography westward of Tubbs' inlet, N. C.—The coast triangulation below Cape Fear has been extended westward by Assistant C. P. Bolles, to the immediate vicinity of the boundary line between North and South Carolina. The details of the plane-table work, which has been prosecuted in connexion with it, have been completed to Tubbs' inlet, and the shore-line survey advanced westward to Little river, (Sketch No. 16,) or near the present limit of the triangulation. On the 10th of December work was resumed at Shallotte inlet, Mr. O. Hinrichs, the aid in the party, conducting the topographical survey, while Mr. Bolles carried forward the triangulation. Most of the angular measurements were made with the six-inch Brunner theodolite C. S. No. 67.

The following synopsis shows the progress made by the party before closing for the season, on the 20th of June:

First order stations occupied	8
Second order stations occupied	30

Objects observed on	46
Number of observations	1,218

In the principal series eighteen angles were determined, the last being formed at a station a short distance above Tubbs' inlet. From thence southward and westward to Little river, the smaller chain of triangles was completed to serve as a basis for the topography.

The impediments from standing wood and undergrowth on this part of the coast increase the natural difficulty of laying out and determining primary lines which pass over a level surface. Avenues, making in the aggregate an extent of more than fourteen miles, were traced and opened by the party so as to admit of observing with the theodolite.

Assistant Bolles furnished in the course of the working season the data requisite for fixing the positions of shore stations for the hydrographic party of Lieut. Comg. Bankhead.

The plane-table work comprises the following statistics:

Beach-line surveyed	21.6 miles.
Shore-line of creeks	102.1 "
Outline of marsh	47.5 "
Roads	30.3 "

In addition to the plane-table work, Mr. Hinrichs aided in the several operations of the triangulation. Shore-line was furnished as needed for the in-shore hydrography, which was in progress at the same time.

Six volumes containing the original records of horizontal angles measured in extending the field-work westward from Cape Fear have been placed in the archives, as also the topographical sheet executed last year under the direction of Assistant Bolles.

Astronomical and magnetic observations at St. Helena Island, S. C.—As part of the duty devolving on his party in this section, Assistant C. O. Boutelle set up the zenith telescope C. S. No. 5, and transit No. 3, at Port Royal station on St. Helena island, and made a series of observations for latitude between the 8th of January and the 1st of March. Both instruments were supported by wooden posts set three feet in the ground and strongly trussed by cross and diagonal braces above and below ground.

The azimuth also was determined at the same station with the twenty-four-inch theodolite C. S. No. 2, and Gambey theodolite C. S. No. 43, an artificial horizon being employed in making the observations with the last-named instrument.

For local time observations were made at intervals from January 8 to May 7 inclusive, with transit No. 3, in connexion with the sidereal chronometer No. 207, and the solar chronometers Nos. 211, and 2,458.

For latitude six hundred and seventy-eight observations were made on sixty-two pairs of stars. The places of forty-eight were taken from the Twelve Year, and the rest from the catalogue of the British Association. Seventy-two observations for value of the micrometor in the zenith telescope were made upon four elongations of Polaris. The value of levels A and B were determined in terms of the micrometer by a hundred and twenty observations on the cross hairs of a sector set up fifteen feet north of the zenith telescope and used as a collimator.

Between the 10th of February and the 16th of March ten elongations of Polaris were observed in the usual manner for azimuth. Two hundred and sixty-three observations were made on star and mark, and one hundred and eighty-six for connecting the elongation mark with stations in the secondary triangulation.

For local time three hundred and thirty-nine transits were observed on sixty-one nights between January 8 and May 7.

Mr. Boutelle also observed a series of azimuths upon Polaris in various parts of its orbit, making thirty-three sets of four repetitions each on three nights. These formed angles between Chaphir signal and the star, and were observed alternately direct and reflected in a mercurial horizon.

The position of the astronomical station on St. Helena island, and its connections with the coast triangulation are shown on Sketch No. 16.

The declination of the magnetic needle at Port Royal station was determined with the declinometer C. S. No. 5, by two hundred and thirty-six observations made in parts of ten days between January 23 and February 5, on two collimator magnets. For the dip, the circle No. 9 was used, and ninety-six observations were recorded.

In the astronomical work, and in the general operations yet to be referred to, Mr. Boutelle was assisted by Lieut. Thomas Wilson, U. S. A., Assistant Coast Survey, and Sub-Assistant W. S. Edwards. Mr. C. H. Boyd was attached to the party as aid.

Duplicates of the records of observations made this season for latitude, azimuth, and time have been deposited in the office. Mr. Boutelle has also turned in his revised computation for the latitude of Allston station, determined in a previous season.

Primary triangulation, coast of South Carolina.—For the extension of the series of primary triangles southward and westward from the Edisto base and in the direction of Savannah, Assistant Boutelle erected a tripod and scaffold at Port Royal station, and made the preliminary measurements necessary for including a point in the city of Beaufort, S. C., in the general scheme. The positions of these, as falling in with the chain of work already completed, may be seen in the progress sketch (No. 16) of the section. The lines to be observed on in carrying the main triangulation across St. Helena island were partly traced and cleared for the measurement of horizontal angles while other operations were going on. This service was performed by Sub-Assistant Edwards, under the direction of Mr. Boutelle. The party reached its working ground in the schooner Petrel from Charleston, at which port the vessel had been laid up during the winter.

Lieut. Wilson, U. S. A., and Mr. C. H. Boyd, assisted in the duties now under notice, and in those to be mentioned under the next head.

The records of the primary triangulation of previous years have been deposited in the archives.

Triangulation of Beaufort, Chechessee, and Colleton rivers, S. C.—From its entrance into Port Royal sound, Assistant Boutelle laid out and completed by the 19th of April the triangulation of Beaufort river upwards to the city of Beaufort. The length of water course included in that work is about twenty-nine miles. His party was then transferred in the schooner Petrel to Foot Point, and in that vicinity a triangulation was carried from Broad river up the Chechessee and its branch known as the Colleton river. The triangles were made to extend about two miles and a half above Foot Point and four miles below it, so as to provide for the topographical survey, and for hydrographic purposes, reference to which will be made hereafter.

The following are statistics of field-work executed by the triangulation party:

Signals erected	20
Stations occupied	24
Angles measured	348
Number of observations	1,772

A general view of the scheme of work will be seen by reference to Sketch No. 16.

The eight-inch Gambey theodolite, C. S. No. 24, and ten-inch Gambey, C. S. No. 43, were used in the angular measurements.

In the several operations prosecuted between the Edisto base and Foot Point Mr. Boutelle was assisted by Lieutenant Wilson and Sub-Assistant Edwards. Mr. C. H. Boyd was attached to the party as aid.

The schooner Petrel was despatched for New York on the 16th of May, and was there repaired and refitted for the continuance of work in the coming season.

While the triangulation party was at work in February, the United States steamship Brooklyn passed into Port Royal sound and anchored near the Parry island buoy, between Broad and Beaufort rivers. Assistant Boutelle visited the vessel, and, as no professional pilots are known in that vicinity, tendered his services in conducting her up Beaufort river. The offer being accepted by Captain Farragut, of the Brooklyn, the steamer was moved to a position within four and a half miles of the city of Beaufort, and there anchored. A communication addressed to me by Captain Farragut, in reference to his visit in Port Royal sound, is given in Appendix No. 38.

After reporting at the office, Assistant Boutelle proceeded to Section I. His occupation during the summer and autumn has been stated under that head. Lieutenant Wilson, on returning from Section V, was assigned to duty in the charge of the Drawing Division, and Sub-Assistant Edwards took up plane-table work on the Kennebec river.

Triangulation of Doboy and Altamaha Sounds, Ga.—The secondary triangulation on the coast of Georgia has been continued southward from the Sapelo base, and between it and the work at St. Simon's entrance a preliminary connexion has been made by a series of tertiary triangles carried along the outer range of islands below the entrance to Altamaha sound.

Sub-Assistant F. P. Webber, whose operations last season closed at the upper part of Sapelo island, resumed work there on the 20th of December, with a party in the schooner Hassler. The triangulation was taken up at the line which joins Julienton with a terminus of the Sapelo base, the location of which is marked on Sketch No. 16. To the southward and westward stations were erected at suitable intervals, so as to include in the secondary series Mud river and North river, with their branches behind Sapelo island; Doboy sound, and Altamaha sound with the lower parts of its tributaries. A number of subsidiary stations were occupied within the same area sufficient for the purposes of a topographical survey. Mr. Webber measured also a series of tertiary triangles, in order to define the courses and direction of the water-passage which separates Blackbeard island from Sapelo island, and south of the Altamaha entrance extended a similar triangulation by observing alternately at stations on St. Simon's island in connexion with others erected on the chain lying between it and the ocean. The ten-inch Gambey theodolite, C. S. No. 63, was used in measuring the angles.

At a station about thirty miles below the Sapelo base, as measured along the course of the triangulation, a junction was made with one of the tertiary lines observed on by Assistant A. W. Longfellow in the survey of St. Simon's sound. Sub-Assistant Webber there closed for the season on the 15th of April. It is expected that a connexion by triangles of the second order can be made early in the ensuing year.

Mr. Julius Kincheloe was attached to the party as aid, and served efficiently in the field-work and in making computations.

While the hydrographic survey of Sapelo bar was in progress, the points requisite for it were

furnished to Lieut. Comg. Fauntleroy. Further notice in regard to that work will be made under another head.

The following summary of statistics and extract are from the report of Sub-Assistant Webber:

Secondary stations occupied	7
Tertiary stations occupied	42
Angles measured	562
Objects observed on	570
Points determined in position	105
Number of observations	3,958

"The sides of the triangles of the second order range from five to eight miles in length. It is probable that lines from four to six miles long can be found across the opening to the west of St. Simon's island, but in proceeding southward it will be necessary to erect two or three scaffold signals, perhaps twenty-five feet high, as the lines will extend over fresh water marsh, the reeds and shrubs of which reach to a height of twelve and in some places twenty feet, while the hard ground is nearly level with the surface of the marsh."

Records of the horizontal angles and descriptions of the signals erected this season have been received and filed in the office.

The schooner Hassler with the party of Mr. Webber reached Portland, Me., on the 2d of May, and during the summer was employed in work east of the Kennebec. On her outward passage to the south, the vessel was forced to take refuge in Provincetown harbor by severe gales, and while again on her way was damaged off Long Island in a storm, which also destroyed her stern boat. The necessary repairs were made at Savannah.

Sub-Assistant Webber is now making arrangements for returning to continue work on the coast of Georgia.

Shore-line survey from St. Helena sound, S. C., to Savannah river entrance.—This includes the outlines of the Hunting islands, Eddings' island, the islets and water-passages between them and St. Helena island, the entire shore-line of Port Royal entrance, and part of that of Parry island, at the confluence of Beaufort and Broad rivers, Daw island and Colleton Neck, the outline of Hilton Head island, and the western shore of Calibogue sound, from Pinckney island to Savannah river. The work was executed by Assistant John Seib, whose party arrived in the section and anchored in Harbor river on the 10th of January. After joining with the plane-table survey made in 1856 on the upper part of the Hunting islands, Mr. Seib pushed steadily in the direction of Tybee entrance, tracing, as he advanced, the shore-line of Harbor river, Fripp's inlet, Story creek, Trenchard's inlet, Skull inlet, and Pritchard's inlet, and passing through Station creek, the preliminary work was carried into Port Royal sound. On the outer side of the islands which bound the lower part of the coast of South Carolina, the ocean-line was traced from Skull inlet to Bay Point, at Port Royal entrance. Thence, proceeding northward and westward, the shores of Port Royal sound were surveyed, from Bay Point to Land's end, as also the shores of Beaufort river to a point three miles above its mouth; the northern shore of Broad river, beyond Parry island, and its southern shore as far up as Lemon island. In that vicinity Mr. Cleveland Rockwell, the aid in the party working under my immediate direction, with a second plane-table traced the outline of Daw island; the shores of the Chechessee river, from Pinckney island upward to Lemon island; and the shores of Colleton river to a short distance southward of Foot Point. The tongue of land embraced between the

two rivers, and designated as Colleton Neck or Victoria Bluff, was surveyed somewhat in detail. A tracing from the topographical sheet of Mr. Rockwell was furnished early in May for the guidance of the hydrographic party in sounding out the adjacent channels, more particular reference to which will be made presently.

The continuous preliminary work of Assistant Seib in going southward from Port Royal sound embraced both shores of the passage known as Skull creek, between Pinckney island and Trench's or Hilton Head island; the shores of Calibogue river, in connexion with it and with May river; and the shore-line of Calibogue sound, to Mungen Point. The outer side of Hilton Head island also was traced and joined with the surveys already mentioned. As measured in a direct line, the chain of islands included in the work of the season stretches about thirty-five miles below St. Helena sound. The aggregate of shore-line represented on the five plane-table sheets brought from the field is about two hundred and fifty-eight miles. Four of them were worked on alternately by Assistant Seib and Mr. Rockwell, progress being made at the same time in inking plane-table sheets of the previous year. The limits of the sheets embracing the preliminary survey between St. Helena sound and Savannah river are marked on Sketch No. 16. Field-work was closed for the season on the 12th of May. The schooner Bailey, which had been in the service of the party, then sailed for Smithfield, North Carolina, and was transferred to Lieut. Comg. Bankhead, and employed in the hydrographic work of this section.

At the end of April I visited the party of Assistant Seib, in passing southward on a tour of inspection. The work then in progress, and since completed, is intricate in character and was not favored by more than an average of fair weather for field duty. The large return in results is mainly due to the constant energy of the chief of the party, and to the able support given by Mr. Rockwell.

Mr. Seib was employed during the summer in plane-table duty in Section III, and Mr. Rockwell in Section II. In the corresponding chapters of this report notice has been taken of the occupation referred to.

Topography of St. Catharine's sound, Ga.—The party assigned to this work, in charge of Sub-Assistant H. S. Du Val, commenced the survey on the 27th of December and continued in the field until the 23d of May, using data furnished by the triangulation of Lieut. A. W. Evans, U. S. A. No interruption from unfavorable weather occurred to break the plan of operations, and, as a result, the survey of the shores of the sound was essentially completed, including the shores and branches of that part of the "Inland Passage" known as Bear river, which connects St. Catharine's with Ossabaw sound. The plane-table sheet also embraces the shores of the Medway opposite to the entrance of St. Catharine's sound, the mouth of North Newport river leading from it southward as part of the inland passage to Sapelo, and the outer shores of Ossabaw and St. Catharine's islands, in the vicinity of the entrance. These localities, as well as the general limits of the sheet referred to, are marked on Sketch No. 16.

A reconnaissance was made in the course of the season, and points were established for the survey of the interior of Ossabaw island, on which the work will connect with a survey made to the northward by Assistant A. M. Harrison in 1857–'58, but the advance of the season did not admit of the execution of the topographical details. These will be filled in during the coming winter, the party being about to resume duty on the coast of Georgia. The northern part of St. Catharine's island will be represented on the same sheet, and the detailed work

extended southward to meet that completed on Sapelo sound, which is already connected with it by a shore-line survey along the outer side of the island.

As returned to the office the topographical sheet of St. Catharine's sound exhibits the following summary of progress made by the party in charge of Sub-Assistant Du Val:

Shore-line	204 miles.
Area of details, (square miles)	50

Mr. J. D. Bradford aided in the field-work.

In June the party returned to Portland in the schooner Meredith. The vessel was then transferred to the party of Assistant A. W. Longfellow for service in Casco bay.

Sub-Assistant Du Val makes special mention in his report of the facilities tendered by residents on St. Catharine's island as tending to the furtherance of his work.

Within the present season Assistant Longfellow has inked and sent to the office the plane-table sheet containing his survey of Sapelo sound, and one of the sheets of work executed by his party at Brunswick harbor, Ga.

In-shore hydrography from Cape Fear westward to Tubbs' inlet, N. C.—The hydrographic party detailed for duty in the northern part of this section sailed from Baltimore under the command of Lieut. Comg. J. P. Bankhead, U. S. N., Assistant Coast Survey, in the schooner Crawford, and reached Charleston on the 7th of February. A period of stormy weather setting in made it expedient to defer the outside soundings and employ the interval in another locality, which was accordingly done, as will be noticed presently. The coast soundings from Cape Fear westward to Tubbs' inlet were executed between the 5th of May and the 12th of August, favorable intervals being taken between those dates for also running off-shore lines, to be alluded to hereafter. The in-shore work connects with the completed hydrography of Cape Fear entrance and the Frying Pan shoals, and represents a space of twenty-five miles in length (Sketch No. 16) by rather more than ten in average breadth.

Assistant C. P. Bolles, in charge of the triangulation, furnished data for establishing the shore stations required in executing the soundings.

The following is a synopsis of the statistics:

Miles run in sounding	1,121
Angles measured with the sextant	1,322
Angles measured with the theodolite	2,281
Number of soundings	6,333
Area sounded, (square miles)	228
Tidal stations occupied	2

Referring to the character of the bottom and to the capacity of the several small inlets which break the coast of North Carolina at intervals between Oak island and Tubbs' inlet, Lieut. Comg. Bankhead remarks: "The bottom is uniform in character and clear of rocks or shoals, and the shore can be safely approached, in clear weather, by any class of vessels to within one nautical mile."

"The inlets are impracticable for any but vessels of very light draught, and their bars change with every shift of wind. A few flat-bottomed schooners are the only vessels that

attempt the passage, and then only on the top of high water, when not more than six feet can be carried in under the best of circumstances."

The in-shore hydrography from Cape Fear westward was executed with the schooners Crawford and Bailey, the latter having been assigned for that duty on the close of topographical work conducted in this section by Assistant Seib. In the course of the autumn the soundings were plotted under the direction of Lieut. Comg. Bankhead, at Washington, and the resulting chart left at the office.

The original records and transcripts of the soundings and tidal observations made at the Cape Fear entrances in 1857–'58 by the party of Lieut. Comg. T. B. Huger have also been received and deposited in the archives.

Off-shore hydrography from Cape Fear to Charleston harbor.—The working season proving to be unusually stormy along the coast below Cape Fear, effective progress in off shore soundings could be made only by employing favorable intervals, the in-shore work already referred to, being from time to time suspended for that purpose.

In allusion to the precautions taken in prosecuting the off-shore hydrography from Cape Fear, southward and westward, to Charleston harbor, Lieut. Comg. Bankhead, says: "Nearly all the lines were run with a fair wind, smooth water, and in clear weather, and all the principal positions were determined by actual observation. The soundings were made with care, and of the specimens of bottom brought up such have been preserved as were at all curious or different from the general character already known."

The following reference is made in the season's report to the probable existence of a bank off Cape Romain, the full development of which will be made in prosecuting the in-shore hydrography southward from its present limit: "I am satisfied that the continuance of the survey off Cape Romain will develop less water in some places than has been generally supposed to exist as I have found six fathoms and water breaking in heavy weather where we should have inferred a depth of nine or ten fathoms from the general chart."

The off-shore soundings made by the party of Lieut. Comg. Bankhead in the schooner Crawford were carried to an average depth of a hundred fathoms, or from sixty or seventy miles from the coast, and were executed between the 7th of March and the 5th of August.

During the last two months of the season every effort was made to obtain current observations, but excepting at two stations in the vicinity of Cape Fear, without success.

The statistics of the off-shore hydrography are given in the following summary:

Miles run in sounding	1,462
Number of soundings	1,193

An unusually late period of the working season at the south having been reached, the schooners Crawford and Bailey sailed for New York, and there underwent necessary repairs. The plotting of the off-shore chart was then taken up, at the office, and completed.

Arrangements are now in progress for the return of the vessels and continuance of the in and off shore work in this section.

Hydrography of Bull's bay, South Carolina.—This duty was executed by the party of Lieut. Comg. Bankhead, with the shooner Crawford in March and April, the boisterous character of that part of the season not affording the usual opportunities for pushing soundings outside of the main coast. In connexion with the bay, the inland passage leading to the southward and westward, was sounded out as far as Capers's island. The limits of the sheet containing the

hydrography are marked on Sketch No. 16. Regular tidal observations were made during the period occupied in the work.

Lieut. Comg. Bankhead thus refers to Bull's bay as a harbor of refuge: "I doubt whether it will ever be used except as a harbor of refuge for coasting vessels, for which purpose, however, it is well adapted, being easy of access, affording good holding ground, and having abundant water (in the channel) for that class of vessels. The small channels that traverse the bay are too narrow and irregular in their depth for anything but boats of the lightest draught."

The following allusion to the inland passage is made in the same report:

"The inland passage connecting with the bay I find to be too narrow and crooked for any vessels other than very small steamers and flat boats, there being but one foot of water at mean low tide, and a width of only fifty feet at the narrowest part."

The following are statistics of the hydrography:

Miles run in sounding	308
Sextant angles taken	736
Number of casts of the lead	20,345
Area sounded (square miles)	36

The chart of Bull's bay resulting from this work has been plotted and is now on file at the office.

While engaged on his working ground in this section Lieut. Comg. Bankhead furnished to a deputation from Charleston, sent to examine in regard to the availability of Bull's bay for a quarantine station, such hydrographic data as could be supposed to bear on the question.

Hydrography of Port Royal entrance, South Carolina.—Early in June, Lieut. Comg. C. M. Fauntleroy, U. S. N., assistant Coast Survey, having completed the hydrographic duty assigned in two other localities of this section, commenced an examination of the several channels leading into Port Royal entrance in order to determine the character of the bars. This duty was completed before the close of that month, and, after plotting the soundings, it was reported as the result of comparison that "little or no change has occurred since the date of the hydrographic reconnaissance made in these waters by Lieut. Comg. Maffitt," (1855.)

In connexion with the hydrography of the east channel the soundings were carried northward and eastward to Hilton Head, and so extended in that vicinity as to include Joiner's bank. The limits of the work are marked in the usual way on sketch No. 16.

A recommendation from Lieut. Comg. Fauntleroy in regard to buoys for the east channel passage into Port Royal was communicated to the department in July, (Appendix No. 43.)

The United States sloop-of-war Brooklyn, having touched on a sand-spit at the mouth of Beaufort river, South Carolina, on the occassion of her visit to that branch of Port Royal sound in the early part of the season, to which allusion has been made under a previous head of this chapter, the locality in question was carefully examined by the hydrographic party. No obstruction was found in the channel which leads up the river, the point of the spit referred to being "on the port hand of the channel way, dividing it from a deep water pocket on the port hand of that again." It is hence to be concluded that when the vessel touched she had not fairly entered the channel of Beaufort river. No professional pilots were cruising in Port Royal sound at the period of her visit.

The statistics of the survey made by the party in the schooner Varina are as follows:

Miles run in sounding	158
Angles observed	703
Number of soundings	8,118

The area sounded out is about twenty-two square miles. A tidal station, as usual, was occupied for hydrographic purposes. After some needful repairs at Charleston, the Varina sailed for New York, and arrived at that port on the 8th of July. The party then took up the hydrography of Hudson river, as stated under Section II.

Hydrography of the Chechessee and Colleton rivers, S. C.—After completing a survey, which will be described under the next head, the party of Lieut. Comg. Fauntleroy was transferred in the schooner Varina to Broad river, S. C., and proceeded to sound out the more important parts of its tributaries, designated as the Chechessee and Colleton rivers. From the point of their junction behind Daw island, as shown on Sketch No. 16, the hydrography was carried about two miles northward and westward up the Chechessee, and about three miles southward and westward in the bed of the Colleton river. The vicinity of Foot Point was thoroughly sounded, as also the Chechessee river from the point of Colleton Neck downwards about four miles to Pinckney's island at the head of Port Royal sound or Broad river, where the work joins with the hydrography executed by Lieut. Comg. Maffitt, U. S. N., in 1855. My report for that year was accompanied by a preliminary chart of Port Royal entrance, which is therein marked as Sketch No. 22. In reference to it Lieut. Comg. Fauntleroy observes: "The previous survey shows that the bar of the Chechessee river affords twenty feet at mean low water, with a mean rise and fall of 6.6 feet. The depth increases in passing upward, and vessels that enter Port Royal sound will find in the Colleton river at the Neck, and at its confluence with the Chechessee, a capacious, completely protected and easily accessible anchorage in from four to seven fathoms water." In the Appendix (No. 29) further extracts are given from the report of Lieut. Comg. Fauntleroy bearing on the commercial facilities of the vicinity of Colleton Neck. This hydrographic survey followed the shore-line as traced by Mr. C. Rockwell, and was completed between the 13th and 21st of May. The resulting sheet is now on file in the Coast Survey office. The rate of the currents was observed at two stations, and the rise and fall of the tide determined as usual, the record being made for a complete lunation. An abstract from the hydrographic journal is given below as showing the statistics of work:

Miles run in sounding	218
Angles observed	1136
Number of soundings	15509

Hydrography of Sapelo bar and its approaches, Ga.—The survey of Sapelo river and sound, including its entrance and approaches, has been completed; the supplementary soundings and requisite tidal and current observations having been made this season in the vicinity of the bar by Lieut. Comg. Fauntleroy. Two vessels, the schooner Varina and steam tender Fire-Fly, were used for this service. Inside of the entrance the additional soundings were joined with the work executed in 1857–'58 by the party of Lieut. Comg, J. H. Moore, U. S. N., and from thence carried ten miles seaward to a depth of eight and a half fathoms. North and south the hydrography of the approaches was developed within a stretch of about ten miles. On the resulting chart, the limits of which are marked on Sketch No. 16, the character of the approaches is shown within an area of ninety-four square miles.

Observations were made at two current stations while the work was advancing, and the tides were recorded from the 27th of February until the completion of the survey, on the 27th of April. The soundings were frequently interrupted by bad weather. A synopsis of the statistics follows, as given in the report made on concluding the survey:

Number of theodolite stations	6
Angles of determination	45
Angles observed in sounding	1,018
Miles run in sounding	616
Number of casts of the lead	29,404

The importance of Sapelo entrance as a harbor is well set forth in some remarks contained in the report of Lieut. Comg. Fauntleroy, extracts from which will be found in Appendix No. 30.

Surveys made by this party subsequent to the completion of work at Sapelo bar have been described in this chapter, and under the head of Section II its more recent occupation has been noticed.

Two sheets, containing the hydrography of Sapelo sound and river, were received from Lieut. Comg. Moore, previous to his detachment from the Coast Survey.

Tidal observations.—The permanent self-registering tide-gauge at the custom-house wharf, Charleston, S. C., under the charge of Mr. W. R. Herron, has been kept up with great regularity throughout the year.

SECTION VI.

FROM ST. MARY'S RIVER TO ST. JOSEPH'S BAY, INCLUDING THE EASTERN AND PART OF THE WESTERN COAST OF FLORIDA, WITH THE FLORIDA REEFS AND KEYS.—(SKETCH F, Nos. 20 and 21.)

The progress made in the survey of the Florida reefs and keys has permitted additional parties on the main coast. There have been at work in this section—one party on the line across the head of the peninsula; one triangulation party near St. Augustine; one near Indian river; one on the inner keys, between Cards' Sound and the Gulf of Florida; one in Charlotte harbor; one topographical party on the coast of Key Biscayne and Cards' sound and the keys near Cape Sable; one at Charlotte harbor; one hydrographic party upon the reef and in the Florida channel and Gulf Stream. Observations of the tides have been completed at three stations, and the permanent tidal station at the Tortugas has been kept up for comparison.

The following chapter gives an account of the operations of these several parties, under distinct heads, as follows:

1. Air-line triangulation across the Florida peninsula.
2. Triangulation of St. Augustine harbor and North river, Florida.
3. Triangulation of Indian river inlet, Florida.
4. Triangulation of the Florida keys.
5. Triangulation of Charlotte harbor, Florida.
6. Topography.—Key Biscayne bay, Cards' sound, and Florida keys, near Cape Sable.
7. Topography of Charlotte harbor, Florida.
8. Hydrography of the Florida Reef.
9. Tidal observations.

Office-work.—Progress has been made in the drawing and engraving of coast map and chart No. 68, Florida reefs from Key Biscayne to Carysfort reef, and in the drawing of Nos. 70, 71, and 72, Florida reef and keys from Long key to Marquesas key.

Air-line triangulation across the Florida peninsula.—This work was resumed in January, and continued until the 4th of June. The party engaged in its prosecution was conducted by Capt. M. L. Smith, U. S. Topographical Engineers, Assistant Coast Survey. Messrs. J. S. Bradford and W. H. Gardner were assigned as aids at the outset of the season, and Mr. J. C. Young before its close.

In allusion to the progress made and impediments found as the triangulation advanced southward and westward from Big creek and Padgett station, both of which are shown on Sketch No. 20, Capt. Smith remarks: "It was supposed at the commencement of the season that the ground to be passed over would prove more favorable than that met with during the previous year, but the contrary was the case. New River swamp, which, according to the maps of the interior, our lines should have missed, covers much of the ground traversed by one of the sides of each triangle. The section of country through which they pass is more or less densely timbered, and the lines forming their sides had to be opened foot by foot with the axe. When it is considered that thick pine woods offered the most favorable cutting required in carrying the work forward, the remainder and about an equal portion being through the swamps and matted bogs of the south, the extent of the labor may be judged of. The opening of the lines constitutes the main item of expense attending the triangulation."

Mr. J. S. Bradford was in active charge of the party under the direction of Capt. Smith, and is mentioned, in conjunction with Messrs. Gardner and Young, as having pressed the work with constant energy and interest. In opening the lines, which stretch in the aggregate a hundred miles, the patient endurance of the aids was such as to call forth the warm commendation of the chief of the party.

The work has now advanced from Fernandina about eighty miles in the direction towards Cedar keys, and two more seasons' work, with favorable weather, will probably complete the line; but with impediments like those encountered this year it would require three.

Operations were closed for the season at Waldo station, which is about twenty-eight miles southwest of the station at which the triangulation was resumed in January. Five signals were erected, and ninety angles measured in extending the triangulation to its present limit.

A topographical sheet, embracing the tract over which the season's work extends, has been filed in the office.

Triangulation of St. Augustine harbor and North river, Fla.—The survey of the western coast of Florida was commenced on the 4th of January by Sub-Assistant Benjamin Huger, jr., in the vicinity of St. Augustine. After selecting a site suitable for a base line on the pine barren about a mile west of the city, a triangulation was laid out to extend over the harbor, and north and south of it along the coast. The preliminary base was measured early in June with the contact slide apparatus devised by Assistant Hilgard, and described in my report for 1857. Sketch No. 20 shows the location of the line, and also the system of triangles connected with it. The angles were determined with the ten-inch Gambey theodolite, C. S. No. 74.

Above St. Augustine the completed triangulation stretches twenty miles, and embraces throughout that distance the course of the North river. The scheme was laid out and signals erected along the shores of Matanzas river for carrying the work twelve miles southward from

the base, but the late period of the season reached in the performance of that service made it necessary to postpone the measurement of the angles until the coming winter.

Mr. Rufus King, jr., served as aid in the triangulation party.

The progress made in the field-work is exhibited by the summary of statistics given below:

Stations occupied	24
Signals observed on	38
Angles measured	158
Number of observations	2,696
Area of triangles, (square miles)	50

Field operations were continued in the neighborhood of St. Augustine until the 23d of June. Sub-Assistant Huger, after returning to the north, duplicated and turned in the records of his observations, and then commenced the computations connected with the work.

In the latter part of April, while on a tour of inspection at the south, I visited the site then occupied by the triangulation party, and was gratified with an examination of the arrangements for working in accordance with the plan laid out.

In reporting on the progress of the party, Mr. Huger expresses his obligation to G. R. Fairbanks, esq., vice president of the Florida Historical Society, for information in regard to localities falling within the limits of its operations. The arrangements of the party are now in progress for returning to extend the coast triangulation southward from St. Augustine.

Triangulation of Indian River inlet, Fla.—In the field arrangements made at the opening of the surveying year a new centre of work was selected for extending the triangulation of the eastern coast of the Florida peninsula, the execution of the details being entrusted to Sub-Assistant J. A. Sullivan. The intention of commencing in the immediate vicinity of Cape Cañaveral, and pushing the work towards St. Augustine, was found to present greater obstacles without a corresponding advantage over a beginning made lower down the coast, and in consequence the party proceeded to Indian River inlet. Mr. Sullivan made a reconnaissance in the middle of January for a base site and for stations to connect with it, so as to lead either northward or southward, as might prove most expedient in prosecuting the triangulation. The site chosen rests on the narrow strip of land which separates Indian river from the Atlantic ocean, and is marked on Sketch No. 20.

A preliminary measurement, without correcting for the temperature of the rods used, gave for the line an approximate length of 2,860 metres. Sub-Assistant Sullivan made a topographical survey of the immediate vicinity of the base, and on his return deposited in the office the sheet containing it. As the line passes close to the water margin of the Atlantic, the ends were referred back eight metres from the beach, and carefully secured by placing stone posts on a sand ridge above the ordinary action of the ocean swell. Each terminus was marked by two stone blocks about two feet in length, surrounded by wooden curbs, and having range marks cut on them to correspond with the terminating points of the line laid out on the beach.

The preliminaries being completed, five stations were established, with signals visible over the high mangrove keys which lie inside of Indian river and abreast of the inlet. These connect with both ends of the base line. The scaffolds erected are twenty-five feet in height. Two of the stations rest on the western side of Indian river, as will be seen by reference to the Sketch; the others on the strip of land south of the inlet.

The time allotted for observations with the theodolite proving unfavorable, materials were

prepared for the second order signals required along the shores of Indian river, in which duty the party was occupied until the 25th of March.

Sub-Assistant Sullivan commends the zeal, perseverance, and hearty spirit of co-operation shown by his aid, Mr. R. M. Stiles, in all the labors of the season. Special reference is also made in the field report to the courtesies and assistance rendered to the party by Major W. F. Russell, of Fort Capron.

The schooner Benjamin Peirce, which was used in prosecuting the work at Indian river, was caught in a gale and damaged, on the return passage, off Cape Cañavaral. After the necessary repairs at Savannah, the vessel proceeded north, and was laid up at New York.

In June Mr. Sullivan was assigned to duty in Penobscot bay, the details of which have been given under the head of Section I. His party is now about to return to continue the triangulation near Fort Capron, Fla.

Triangulation of the Florida keys.—For continuing duty on that part of the Florida reef which approaches nearest to the Cape Sable base, the party of Lieut. A. H. Seward, U. S. A., Assistant Coast Survey, took the field on the 13th of December, using the schooner Torrey for transportation. After putting up the requisite signals, the triangulation inside of the reef was resumed at Lignum Vitæ key, and extended eastward sixteen miles to Pigeon key. The triangles laid out and measured, as well as the general progress made in the survey of the keys, will be seen by reference to Sketch No. 21. At several of the stations used by Lieut. Seward tripods, for the theodolite, were found necessary, the platforms of which were elevated to a height of twenty-eight and thirty feet from the surface of the keys on which they rested. The work was somewhat retarded by the difficulty of passing the vessel through the intricate channels of that part of the reef, favorable winds only enabling the party to move from one station to another. Lieut. W. Myers, U. S. A., assisted Lieut. Seward in the field.

The angular measurements were made with the ten-inch Gambey theodolite, C. S. No. 15. It will be seen by Sketch No. 21 that this triangulation connects with the work of last year, stretching from Cape Sable, and that it reaches well towards a junction with the triangulation which extends along the main of the peninsula from Cape Florida into Barnes's sound.

The statistics for the season, terminating on the 2d of April, are as follows:

Stations erected	11
Stations occupied	11
Number of observations	2,598
Area included in triangles, (square miles)	62

Descriptions of the signals, and a duplicate of the record of horizontal angles, have been received at the office.

On closing for the season the vessel was despatched for New York, and was there laid up during the summer. The keys yet remaining to be defined in position and outline are surrounded by water so shallow as to render the approach to them very difficult.

Triangulation of Charlotte harbor, Fla.—This work has been continued and nearly completed by a party in charge of Lieut. W. R. Terrill, U. S. A., Assistant Coast Survey, who made a reconnaissance for its extension above Captiva Pass in the latter part of December. Signals were erected on the chain of islands which lie outside and abreast of Charlotte harbor, and along both of its shores to a distance of thirty miles, terminating at Mangrove Point, the position of which is shown on one of the progress sketches of this section, (Sketch No. 20.)

The signal at Captiva Pass, erected and used in the winter of 1857–'58 by Lieut. J. C. Clark, U. S. A., had been washed away, and, in consequence, it became necessary to reoccupy the station connecting with it to the southward on Captiva island. At three stations in the range of this season's work Lieut. Terrill observed from scaffolds fifty feet in height, the lines passing over dense mangrove, through which cuttings for sight on the signals would have involved great expense of labor and time.

The measurement of angles was begun early in January with the ten-inch Gambey theodolite, C. S. No. 81, and was prosecuted at all favorable intervals until the 1st of April, the completed observations then resting for the season at station Oso, lying outside, and station Torrey on the eastern shore of Charlotte harbor. Both of these stations are marked on Sketch No. 20. Points for the use of the topographical party, conducted jointly by Sub-Assistants Dorr and Ferguson, were provided as the triangulation advanced.

Sub-Assistant Clarence Fendall joined the party of Lieut. Terrall at the opening of the year, and assisted him in the field until the 13th of March. Mr. C. B. Baker served as aid during the season. The schooner Bowditch reached New York, on her return from this section, on the 14th of April.

In the report made by Lieut. Terrill the following abstract is given, showing the progress made by the party while working under his direction:

Number of signals erected	24
Stations occupied	11
Signals observed on	24
Angles measured	75
Number of observations	4,376

The triangulation completed this season covers an area of about a hundred and thirty square miles. The original records of angles, as observed in the prosecution of the work, and descriptions of the stations and signals, have been received at the office.

Lieut. Terrill resumed field duty in June with the party of Assistant Edmund Blunt, reference to which was made in describing the work done in Section II. Sub-Assistant Fendall was at the same time assigned to plane-table duty, as stated under Section I.

Topography—Key Biscayne bay, Cards' sound, and Florida keys, near Cape Sable.—With a view of pushing the plane-table work in the vicinity of the Florida reef as far as practicable with a single party, the schooner Agassiz was despatched from Baltimore on the 28th of October, 1858. Much rough weather delayed the vessel, and, in consequence, the working station in Key Biscayne bay was not reached until the 20th of November. After making a reconnaissance, and setting up signals on the western shore of the bay, Sub-Assistant C. T. Iardella started with the plane-table at Shoal Point, and traced in the main shore of the peninsula of Florida, southward and westward to Clay Point, a distance of over thirty miles in a direct line. The tongue of land which from thence projects towards the reef was followed up to the narrow creek dividing it from Key Largo, and the survey of the western side of that key was completed. The shore of the main within the limits just stated is broken by thirty-three small creeks, all of which are represented on the plane-table sheets. Several small keys lying in the lower part of Key Biscayne bay, and in Cards' sound, were also surveyed. This work is embraced on four sheets, the localities included in each of which are marked on Sketch No. 21

The triangulation in Barnes's sound not admitting of further progress in the topography until

pushed southward, Mr. Iardella moved his party to the vicinity of Buchanan key and projected two sheets to include the numerous small keys intervening within the stretch of about sixteen miles between it and Sandy key in the direction towards Cape Sable. These fall within the triangulation executed last year by Lieut. A. H. Seward, U. S. A. Twenty-three keys were surveyed, the largest of which is about three-quarters of a mile in length. The positions of the principal ones are shown on the progress Sketch, No. 21.

Sub-Assistant Iardella discontinued work on the 6th of April, and on the 22d of that month reached New York, where the vessel was laid up.

Mr. F. F. Nes aided in the topographical work, and rendered satisfactory service in the several duties pertaining to the field operations.

In the two localities in which the party was employed great obstacles exist to retard steady progress and to render the work very difficult, and in some places hazardous. Notwithstanding these, the amount of work embraced on the six sheets shows a result which nothing but patience and great energy could have accomplished. The remark just made is also borne out by the statistics, which are as follows:

Shore-line surveyed	168	miles.
Marsh-line traced	16	"
Area represented in detail, (square miles)	40	"

The operations were carried on over an area of more than three hundred square miles. All the sheets containing the work have been inked and deposited in the archives.

As descriptive of the character of this part of the coast of the Florida peninsula, the following extracts are given from the report of Mr. Iardella:

"The main shore, from Shoal Point ten miles southward, consists of a strip of uneven breadth of prairie land called the 'Hunting Grounds.' At some points it is quite narrow, but at others it stretches to a distance of six miles from the western shore of Key Biscayne bay, and is backed by a ridge of high land about a quarter of a mile in width. The ridge as far as Fender Point is covered with large pine trees, but below it, and as low down as Barnes's sound, it bears a heavy growth of black mangrove and other trees. Throughout the entire distance of thirty miles the shore is overflowed by high tides, in some places to a breadth of three or four miles.

"The western shore of Key Largo from Jewfish Point to Largo North, a distance of thirteen miles, is also overflowed at high spring tides; and on many occasions, while engaged there, the surface was found so soft as to require a foundation of mangrove branches for the plane-table. Beyond its western shore this key is covered with buttonwood, mangrove, sea-grape, and other woods. In an extended reconnaissance over that part of Key Largo, very little fast land was found, and no soil fit for the growth of vegetables. * * * * *

"The small keys between Lignum Vitæ and Sandy key are surrounded by extensive mud flats, and are entirely covered with water at high tides. Great difficulties were experienced in obtaining stations for the plane-table, the surface being of the nature of quicksand, into which a man of ordinary weight would at once sink to the waist. Here a triangle of wood six feet on a side was necessary to support the plane-table."

Topography of Charlotte harbor, Fla.—The progress made in extending the survey of this harbor is shown on Sketch No. 20. Early preparations for resuming work were made at the opening of the surveying year, by Sub-Assistant F. W. Dorr; but the schooner Dana, which

sailed from Baltimore on the 25th of November, 1858, with the equipage and instruments of the party, was kept nearly a month on her passage to Key West by storms and head winds. Sub-Assistant Charles Ferguson was associated with Mr. Dorr; and after making arrangements for working jointly to the best advantage, the topography was taken up at the limit reached in the previous year. The work was thus prosecuted northward until the 27th of February, when Sub-Assistant Dorr, in accordance with my instructions, returned to the north, leaving the vessel and party in charge of Mr. Ferguson, who continued plane-table duty until the 16th of March.

The work executed this season includes both shores of Charlotte harbor above its lower entrance from San Carlos bay, and nearly the same extent to the northward as fell within the limits of the triangulation, notice of which has been made in this chapter. The shores are formed by a range of narrow islands and keys on the west, and by Pine island on the eastern side. On the two sheets of this season, both of which have been inked and placed in the office, are represented the northern half of Sanibel island, Captiva island, La Costa island, the western side of Pine island, and the keys, patches, and reefs scattered over the surface of that part of Charlotte harbor which is included between San Carlos bay and Boca Grande. The distance between these last named localities, on a direct line through the waters of Charlotte harbor, is about twenty miles. Lieut. W. R. Terrill, U. S. A., who conducted the triangulation in advance of the plane-table party, furnished the points necessary for the adjustment of the topography. The following is a synopsis of statistics taken from the notes on the plane-table sheets:

Shore-line of islands and keys surveyed	270 miles.
Outline of shoals, etc., traced	48 "

In reference to two of the outlets from Charlotte harbor to the Gulf of Mexico, Sub-Assistant Dorr remarks:

"*Blind Pass*, between Sanibel island and Captiva island, is merely a boat channel, for although the passage is deep in some places, the bars both inside and outside preclude the possibility of carrying through any vessel of draught."

"*Captiva Pass* is about five hundred yards wide. Vessels drawing not more than five feet of water can pass through, but the channel is somewhat intricate."

The following is an extract from the report of Sub-Assistant Ferguson:

"*Boca Grande*, the pass between La Costa and Gasparilla islands, is the proper entrance to Charlotte harbor, containing, at low tide, fifteen feet of water, and inside of the bay three or four fathoms. Vessels passing through can carry eighteen feet some fifteen or twenty miles beyond the northern extremity of Pine island." In the Appendix (No. 31) other extracts will be found descriptive of the features peculiar to the shores of Charlotte harbor.

During the summer Sub-Assistant Dorr was engaged in plane-table duty in Section II, and Mr. Ferguson in similar service in Section III.

Hydrography of the Florida reef.—Lieut. Comg. T. A. Craven, U. S. N., having been reassigned for duty on the Coast Survey soon after his return from the expedition to the Atrato river, resumed the command of the surveying steamer Corwin, which had become vacant by a call for the services of Lieut. W. G. Temple, U. S. N., who conducted the hydrographic operations of last year on the Florida reef, as stated in my annual report. The Corwin sailed

from New York on the 19th of March, and on her arrival at the reef the general hydrography was taken up a little below Eagle cove, where it rested last season in its progress eastward along the outer line of keys. The soundings were continued in the same direction rather more than eight miles, and off the keys about six miles and a half, reaching to an average depth of forty-seven fathoms. At its upper outside limit, as shown on Sketch No. 21, the work now connects with soundings made in the vicinity of Coffin's Patches, by Lieut. Comg. Craven, in 1854. The following statistics are derived from the journals of the present season:

Number of positions for angles	1,206
Angles taken	3,198
Miles run in sounding	462
Number of casts of the lead	18,130

The resulting hydrographic sheet will exhibit an area of about sixty square miles.

Since the opening of the season two charts have been plotted from soundings made by Lieuts. Comg. Craven and Temple, and placed in the office with the original journals and records of the angles. These connect with each other, and contain the hydrography between American shoal and Eagle cove, where the upper limit of the most northern sheet joins with the work last executed.

The steamer Corwin returned to New York early in May, and after being repaired was transferred, under the command of Lieut. Comg. John Wilkinson, for duty, which has been referred to under the head of Section I.

Before leaving the Florida reef, Lieut. Comg. Craven ran two section lines across the Gulf Stream, between Cape Florida and the Tortugas, more extended notice of which will be taken presently.

In passing to the southward the steamer Corwin stood in below Cape Cañaveral, and carried a line of soundings along the coast of Florida as far as St. Lucie inlet. The distance from land being estimated, the depths found have been marked as reconnaissance soundings on the Progress Sketch, No. 36.

As the result of his experience in navigating along the eastern coast of the peninsula, Lieut. Comg. Craven says: "The entire coast south of Cañaveral is safe at two miles from shore until within five miles of Cape Florida. South of latitude 27° N. the shore is bold. I have never had soundings with twenty fathoms, lead 'up and down,' within two miles of the shore. On the passage down, the rate of the current below Jupiter inlet was about two miles an hour, which is more than usual, the wind then blowing from the southeast."

All the journals containing angles and soundings taken this season on the reef have been returned and deposited in the archives.

Tidal observations.—At Fort Clinch, near Fernandina, Amelia island, Fla., observations have been kept up by means of one of the Saxton self-registering tide-gauges, the instrument being under the charge of Mr. F. A. Rebarer until the middle of December, 1858, and since that time in charge of Mr. J. A. Walker.

The self-registering gauges established by Mr. Gustavus Würdemann at Tortugas, Charlotte harbor, and Tampa bay, have given very satisfactory results during the entire year, and are now about to be transferred to stations lying further westward along the Gulf coast of the

adjoining section, (VII.) The plan laid out is to set them up so as to form a chain of stations, at which the results may be comparable with each other and with others in this section through the standard station of reference at Tortugas. It has been found impracticable to trace out the anomalies of the tides of the Gulf of Mexico from the detached and comparatively short series of observations heretofore obtained in the progress of the survey; but by the method now adopted, the observations embracing a full year at each station, and being minutely comparable with each other, the different tide waves can be followed, as it were, step by step in their advance along the coast.

GULF STREAM.

In the southern part of the Gulf Stream observations of much interest have been added in the course of the past year. These were made by Lieuts. Comg. T. A. Craven and T. B. Huger, U. S. N., assistants in the Coast Survey, after closing the general hydrographic work conducted by them in Sections VI and VIII, respectively.

Two lines for depth and temperature were run across the stream by Lieut. Comg. Craven, in the steamer Corwin, one from Carysfort light-house (Florida reef) to Orange key, (Bahama bank,) and the other from Sombrero key (Florida reef) to Double Headed Shot key, (Salt Key bank.) The data thus obtained, taken in connexion with the development of the Cape Florida section by that officer in 1855, and of the Tortugas section by Commander B. F. Sands, U. S. N., in 1858, have furnished important information concerning the form of the bottom, the depth, and the temperature of the water in a part of the Gulf Stream to which general observation would assign as its main peculiarity only the velocity of the surface current.

The bottom of the Strait of Florida slopes, at first gradually and then more rapidly, from the Florida to the Cuban side, the deepest water being found near the shore of Cuba. In this deep portion of the trough the cold polar current lies, the temperature at six hundred fathoms, off Havana, being but thirty-eight degrees of Fahrenheit. The deepest part of the strait is off the opening from the Gulf of Mexico, and it shoals towards the line from Cape Florida to Bemini, from eight hundred fathoms to three hundred and fifty. As there is but one general slope to the bottom, so there is but one band of temperature in this strait, the division into cold and warm bands beginning only to the south of the shoal portion in the Atlantic, where the bottom takes its corrugated form.

A discussion of the recent observations is given at greater length in a paper accompanying this report as Appendix No. 25. The results are graphically shown on Sketch No. 35.

On his homeward passage from the Delta of the Mississippi, in the steamer Walker, Lieut. Comg. Huger took soundings on the course towards the Tortugas, and from thence ran across to Havana. The observations made between the last named places verify the results obtained on the same line by Commander B. F. Sands, in 1858.

In the explorations this year, two hundred and thirty-five observations were made for depth and temperature, and twelve specimens of the bottom procured.

SECTION VII.

FROM ST. JOSEPH'S BAY TO MOBILE BAY, INCLUDING THE COAST OF WEST FLORIDA AND THE COAST OF ALABAMA.—(SKETCH G, No. 23.)

This chapter contains notices of the following operations :

1. The extension of the coast triangulation on the western side of the Florida penisula, below Cedar Keys.
2. Connection of the triangulations of St. Mark's harbor and St. George's sound.
3. Triangulation of Santa Rosa sound.
4. Topography north and south of Homosassa river entrance, western coast of Florida peninsula.
5. Plane-table survey of the shores of Ocklokonee bay and St. James's island, between St. George's sound and St. Mark's harbor.
6. Topography of part of Santa Rosa sound, Fla.
7. Hydrographic re-examination of the Cedar Keys channels.
8. Hydrography of St. George's sound.
9. Tidal observations.

Two triangulation parties, one for triangulation and topography, two topographical, and two hydrographic parties have been at work in this section, the second, and one of the last named during only a portion of the season.

Office-work.—The drawing and engraving of the preliminary chart of the eastern part of St. George's sound have been completed, as also the engraving of the preliminary chart of Pensacola harbor. The drawing of the preliminary chart of Apalachicola bay has been finished at the office, and has since been engraved on stone under the direction of the Superintendent of Public Printing.

Coast triangulation south of Homosassa river, Fla.—Two parties, operating jointly as heretofore, left Baltimore on the 15th of December, with the schooner Joseph Henry, to continue the triangulation and topography of the western coast of Florida, below Cedar Keys. Sub-Assistant G. H. Bagwell, in charge of the triangulation, resumed duty at a station near the mouth of Homosassa river, and carried the work twenty-five miles southward, to the vicinity of Bayport, where he closed for the season at the end of March. Sketch No. 23 contains a scheme of the triangles, and shows also the progress which has been made in the other branches of the survey in this section. It will be seen, by referring to the sketch, that the reefy and broken character of the coast approach, as represented on the preliminary chart of Cedar Keys, (Sketch No. 33, C. S. Report for 1855,) holds as far as the parties have advanced to the southward from that centre of work. Mr. Bagwell thus remarks, in reference to that part passed over since the opening of the present surveying year, as connected with the stretch lying northward of it : "The main surface consists of vast flats and shoals which extend miles to seaward from the western shore of Florida, the water gradually deepeniug off among the dangerous rocks of St. Martin's reef."

"Most of the stations observed from were occupied with scaffolds, some of which were built as high as thirty feet, in order to see over the thick hammocks of palmetto and mangrove that obstructed the view. The coast over which the work extended presents many obstacles to triangulation. The chain of keys and shell reefs, on which the outer sides of the triangles rest

from Cedar Keys southward to Chassahowitzka Point, end at the latter place, and below it suitable outer points could be established only by building stations in shallow water. At these a foot or more in depth is left at low tide."

In the course of his work, Sub-Assistant Bagwell determined positions for the use of the topographical party of Sub-Assistant Finney, who co-operated also, as far as practicable, in pushing the triangulation.

The field statistics are as follows:

Stations occupied	12
Signals observed on	29
Angles measured	78
Number of observations	2,060

The observations were made with the-eight inch Würdemann theodite, C. S. No. 86.

During an interval unfavorable for the measurement of angles, Mr. Bagwell made a reconnaissance of the coast from Bayport southward, and through St. Joseph's bay to the southern limit of the section. About thirty miles below Bayport a fine site for a base was found on a straight level strip of sand beach at the north end of Chaldee's key. The length practicable for measurement he reports as being nearly three miles. Between Bayport and Anclote key, a distance of fifteen miles, the difficulties before alluded to in regard to outside stations remain to be encountered. As the result of his observations in reconnaissance beyond that, Mr. Bagwell says: "Southward from Anclote key the triangulation can readily be extended with sides of from two to five miles over St. Joseph's bay and Clear Water harbor."

Mr. M. O. Hering rendered acceptable aid in all the operations of the triangulation party. Before taking the field, the records of last year were duplicated and sent to the office with the observer's computation of results. In April the schooner Joseph Henry returned to New York and was laid up for the summer. Sub-Assistant Bagwell soon after joined the party of Assistant Edmund Blunt, and aided him in the triangulation under his charge in Section II.

Triangulation east and west from St. Mark's, Fla.—The triangulation from St. George's sound, which rested last year at the eastern end of St. James's island (S. W. cape,) was taken up at that point, by Sub-Assistant Spencer C. McCorkle, on the 16th of December. After making a reconnaissance for pushing the work eastward towards St. Mark's and Ocilla river entrance, a system of short lines was determined on, extending over Ocklokonee bay. Such of the lines as required cutting were then cleared and the necessary signals erected. The angular measurements were commenced on the 25th of January, and continued until near the end of April, when a junction was made between the triangulation thus carried from St. George's sound and that executed at St. Mark's river by Mr. McCorkle in 1856. Stations were also erected eastward of St. Mark's and preliminary measurements made in the series of triangles designed to connect that work with the triangulation of Ocilla river. As the operations of the party progressed on the shores of Ocklokonee and Dickerson's bays, points were determined and furnished for the use of the plane-table party of Assistant Wise. An abstract of the statistics is given below, as contained in the report of Sub-Assistant McCorkle:

Stations occupied	19
Angles measured	70
Number of observations	1,404
Area of triangulations, (square miles)	90

The instrument used was the six-inch Gambey theodolite, C. S. No. 55. Sketch No. 23 shows the arrangement of the triangles. The distance from the starting point of the season's work (S. W. cape) to St. Mark's light-house is about twenty-five miles.

In his general report Sub-Assistant McCorkle commends the zeal and intelligence shown by Mr. A. W. Thompson, who aided him both in the field and office work of his party.

On closing work, the schooner Franklin, which had been used for the transportation of the party and materials for the stations, was laid up at Apalachicola.

Mr. McCorkle has sent to the office the original and duplicate of the record of angles measured this season, together with his computation for the lengths of triangle sides.

Triangulation of Santa Rosa sound, Fla.—This work was taken up by Assistant F. H. Gerdes in March, after closing similar duty at the Mississippi delta, reference to which will be more particularly made in the next chapter. The triangulation of Santa Rosa sound joins with that of Pensacola bay on the line connecting Fair Point with a station near the western end of Santa Rosa island, as may be seen on the progress sketch of the section, (Sketch No. 23.) From thence a chain of triangles extending six miles eastward was laid out and measured with the Würdemann theodolite, (C. S. No. 87,) the points requisite for the topographical survey being also determined as the triangulation advanced. A synopsis of the statistics is appended:

Signals erected	10
Stations occupied	10
Angles measured	30
Number of observations	288

Assistant Gerdes was aided in the field by Mr. G. U. Mayo. Soon after the close of work the record of angles observed was duplicated and sent to the office, with an abstract in the usual form.

Topography north and south of Homosassa entrance, West Florida.—The party in charge of this duty was conducted by Sub-Assistant N. S. Finney, and, as heretofore, co-operated in the triangulation work in its progress southward from Cedar Keys, special notice of which has already been made in this chapter.

Mr. Finney resumed the plane-table survey at Mangrove Point, two miles southwest of Crystal reef signal, and traced in outline the entire barrier of islands, rocks, and shell reefs, which extend about seven miles to the southward. These form the most strongly-marked feature of that part of the coast of Florida. The sheet containing the detailed work was terminated at the mouth of the Homosassa river.

An additional vessel for the use of the topographical party not being available, it was found necessary to pass by for the present season a few miles of the coast below Homosassa entrance, in order to keep pace with the triangulation, the same vessel serving for the transportation of the two parties. Plane-table work was therefore taken up at the Chassahowitzka entrance, (Sketch No. 23,) and carried southward about seven miles further to Raccoon Point, the triangulation being still a few miles in advance of it. The characteristics before alluded to apply also to the coast south of the Chassahowitzka river. Both of the sheets containing the results of the survey are marked in positive and in relative proportions on the progress sketch of the section, but the reduced scale gives, of necessity, only a partial idea of the peculiar features contained on the originals. Exclusive of portions of the shore-line of the main land and numerous shell reefs, the sheets represent two hundred and thirty-six soft, marshy islands

as existing within an area of thirty-five square miles. In some places the belt of islands extends five miles beyond the main shore. Above the mouth of the Chassahowitzka the islands are covered at high water, but the marsh of which they consist lies somewhat higher, is much less broken than in other localities, and the zone of patches which lie between the deep water of the Gulf and the firm land of the peninsula becomes narrower.

The plane-table survey was discontinued for the season at a station about five miles north of Bayport.

In the report of Sub-Assistant Finney favorable mention is made of the services rendered by Mr. J. L. Tilghman, who accompanied him in the field as aid. The statistics of work are thus given in the same report:

Plane-table stations occupied	413
Points determined	1,320
Shore-line surveyed at high water, (main, islands, and reefs)	176
Shore-line at low water	54
Area of topography, (square miles)	35

In the field report Mr. Finney expresses his obligations for courtesies extended by Captain James Tucker, of the mail steamship Madison, and for assistance rendered to his party by Colonel E. H. Richards and W. P. Peginan, esq., postmaster at Cedar Keys.

Sub-Assistant Finney was employed during the summer in Section II, as stated in the corresponding division of this report.

Topography of Ocklokonee bay and St. James's island, Fla.—The party of Assistant G. D. Wise, having last season completed the plane-table survey of St. George's sound, started early in January at the terminating limit on St. James's island of the topography commenced and partly executed by Sub-Assistant C. T. Iardella in the season of 1857–'58. The survey of the northern part of the island was completed by Mr. Wise, and on the same sheet the work extended so as to include the shores of Ocklokonee bay. Some progress was also made on a second sheet projected to contain the details of the vicinity of Dickerson's bay and of the coast running from its entrance towards St. Mark's. The localities of the work are marked on Sketch No. 23. The return in statistics is as follows:

Shore-line surveyed	88 miles.
Roads surveyed	10 "
Area of plane-table sheets, (square miles)	46

This survey rests on the triangulation executed within the present season by Sub-Assistant S. C. McCorkle.

Mr. C. W. Duval served as aid in the plane-table party. The work was prosecuted with the use of the schooner Howell Cobb, and on the close of operations the vessel left for the north, and was laid up at Baltimore.

With reference to the Ocklokonee shoal, which lies off the eastern end of St. James's island, Assistant Wise remarks: "The shoal having only two or three feet of water, and being right in the track of a large trade, has occasioned the loss of many valuable cargoes. The bell-buoy which was placed on it soon broke adrift, and, after washing ashore on St. George's island, was

finally lost. It is the opinion of many shipping-masters of the vicinity that a light-ship would best answer the purposes of navigation here as a beacon to mark the shoal."

Topography of Santa Rosa sound, Fla.—After completing the triangulation described under a previous head, Assistant F. H. Gerdes proceeded at once with the plane-table, and surveyed that part of Santa Rosa island which lies in the immediate vicinity of Little Sabine bayou, having an extent of about six miles of Gulf coast on the outside, and the same of inner shore-line. The topographical sheet includes also the opposite shore of Santa Rosa sound from Deer Point eastward to the present limit of the triangulation. An aggregate of twenty-two miles of shore was traced within an area of ten square miles. Sketch No. 23 shows the limits of the plane-table work. This survey furnishes all the topographical details necessary for the chart of Pensacola harbor, an edition of which in a preliminary form has been issued from the office.

Mr. G. U. Mayo aided in the triangulation and plane-table survey of Santa Rosa sound. The work was continued until the middle of May, when Assistant Gerdes proceeded north and reported at the office. His party had been previously employed in Section VIII, as will be noticed further on.

Re-examination of the Cedar Keys channels, Fla.—On his way to Section VIII, Lieut. Comg. T. B. Huger, U. S. N., Assistant Coast Survey, with the hydrographic party in the steamer Walker, stopped at Cedar Keys and sounded out the Main, the North key, and the northwest channels leading into that harbor. The work was performed in the early part of January, and under disadvantages arising from fogs, rain, and northerly winds. As a consequence of the prevailing wind during the period of the stay of the party, the rise and fall of the tide were reduced much below the average, the fall in particular being greater for several days than had been observed in the course of the preceding year.

Lieut. Comg. Huger states that the breadth of the bulkhead across the main channel varies from one hundred to three hundred yards, and, in his opinion, the surface of it could readily be removed so as to afford a depth of twelve feet at low water. An examination made by the party confirmed the facts heretofore reported in regard to the structure and character of the bar.

Lieut. Comg. Huger says: "It is composed of a crust of sand and shells easily penetrated, and after passing through it the bottom is soft, consisting, I think, of mud and sand. I had it sounded with an iron rod, and on trying the heavy lead and specimen cup, found no difficulty in sinking it sufficiently deep to obtain a good specimen."

The soundings made at Cedar Keys were plotted at Pensacola while the steamer was taking in supplies, and the chart on being completed was sent to the office, with the following abstract of statistics:

Miles run in sounding	166
Angles measured	1,242
Number of soundings	15,102
Area of hydrography, (square miles)	5

Lieut. Comg. Huger reports that the northwest channel into Cedar Keys presents, in respect of capacity and direction, several advantages over the channel now used for vessels bound to ports lying westward in the Gulf of Mexico.

Having been fitted out for hydrographic duty in Section VIII, the vessel cleared from Pensacola on the 15th of January for Atchafalaya bay. The work done by the party subsequent to that date will be described in the next chapter.

Hydrography of St. George's sound, Fla.—The party of Lieut. Comg. J. K. Duer, U. S. N., Assistant Coast Survey, resumed work in the vicinity of Apalachicola with the steamer Vixen on the 3d of December, and executed portions of the hydrography inside and abreast of the West Pass. The new channel leading into the sound past the eastern end of Dog island was thoroughly examined, with results confirming those reported after the reconnaissance made last year, that it is by several feet the deepest pass into St. George's sound at all seasons. But the known irregularities of the tides affecting the depth of water in the eastern part of the sound render the determination of the mean rise and fall somewhat difficult without a wider range in the observations than is ordinarily necessary for hydrographic purposes. In order to elucidate the normal peculiarities of the tide wave in its progress along that part of the Gulf coast, series of observations have been directed to be made with self-registering gauges, and arrangements for commencing them are now in hand.

The hydrographic work allotted in this section for the early part of the season was frequently interrupted by bad weather. Soundings were continued until the 10th of March, the vessel and party being then transferred for duty to Section IX, the operations in which will be described in another chapter.

Lieut. Comg. Duer, who had preceded the return of the steamer Vixen to Apalachicola, died at that place on the 14th of June, after which the charge of the party devolved on Mr. A. W. Muldaur, as executive officer, until the assignment of Lieut. C. C. Sims, U. S. N., who took command on the 1st of July and proceeded with the vessel to New York.

As part of a summary report made at the end of the season by Mr. Muldaur, the following statistics are given of the work done in St. George's sound:

Miles run in sounding	564
Angles measured	1,499
Number of soundings	25,060

In the death of Lieut. Comg. Duer the survey has lost the services of a zealous and industrious officer, whose career on the work seemed ever to be marked by devotion to its best interests. He was prompt to act, and thorough in the execution of details assigned to his charge. His discovery of the new channel into St. George's sound, and which now bears his name, will closely associate his memory with the hydrographic history of this section. I have elsewhere more specially alluded to the circumstances attending his untimely death.

My public acknowledgment is here due to Lieut. Sims for the important service rendered by him in accepting the charge of the steamer Vixen when the official command of that vessel was left vacant by the decease of Lieut. Comg. Duer.

In March, while the party was employed near Apalachicola, assistance was rendered to the schooner Lucy Weltham, of Wilmington, N. C., which had gone ashore on the east bank of the West Pass. Similar service was afforded from the Vixen to the mail steamer Galveston in June, when grounded on the east side of the entrance to Apalachicola harbor.

Tidal observations.—The self-registering gauge established at Cedar Keys for recording observations simultaneous with those made at Egmont key, Charlotte harbor, and Tortugas,

has been kept in working order, and has given satisfactory results. The gauges were attended to by Mr. Gustavus Würdemann, who devoted to them his usual care and attention.

I am indebted to S. Thayer Abert, esq., civil engineer at Warrenton navy yard, for the records of a self-registering gauge, the charge of which he kindly undertook when it was set up at that station. Through the interest taken by that gentleman in the subject, the records, as received at the office, have been found highly satisfactory.

As intimated under the head of Section VI, a series of stations are about to be established from St. Mark's westward, along the shores of St. George's sound, and extending as far as Cedar keys to the eastward. By these it is expected that the anomalies noticed in the tides of this part of the Gulf coast may be fully developed.

SECTION VIII.

FROM MOBILE BAY TO VERMILION BAY, INCLUDING THE COAST OF THE STATE OF MISSISSIPPI AND PART OF THE COAST OF LOUISIANA.—(Sketch H, No. 26.)

Two triangulation and topographical parties, one a double party, one topographical party, and one hydrographic party, have been occupied in this section, and their progress is described in the following chapter under the heads of—

1. Triangulation and topography of Isle au Breton sound, La.
2. Triangulation of the Mississippi delta, La.
3. Triangulation of West Côte Blanche bay, La.
4. Topography of Lake Pontchartrain, La.
5. Topography of the Mississippi delta, La.
6. Topography of West Côte Blanche bay, La.
7. Soundings in the Rigolets, La.
8. Hydrographic reconnaissance of Pass à l'Outre, Mississippi delta.
9. Hydrography of Atchafalaya and Côte Blanche bays, La.

Office-work.—The preliminary chart of Atchafalaya bay has been drawn and engraved, and the engraving of coast maps and charts Nos. 91 and 92, Mississippi sound and Mobile bay, from Bon Secours bay to Grand island, has been in progress.

Triangulation and topography of Isle au Breton sound, La.—Connecting with stations of the primary triangulation westward of Mississippi sound, others have been occupied suitable for carrying a branch southward from the general series of triangles, so as to include the survey of Chandeleur sound and that of Isle au Breton sound. This duty was intrusted to Sub-Assistant Stephen Harris, and has been successfully accomplished, as will be seen by the plan given on Sketch No. 26, the triangulation now extending as low down as Point Fortuna, or within twenty miles of the Mississippi river.

In order to join properly with the completed range of triangles resting on Lake Borgne, Mr. Harris was directed to reoccupy the station Nine Mile Bayou, which had been used in the primary work, but the granite block placed there as a mark in 1852 could not be found. The shell bank in which it was then fixed had in the interval been removed as material probably for roads. After making a reconnaissance to the southward with the schooner Twilight, Mr. Harris resumed the triangulation at station Sand Fly early in December. In passing towards Isle au Breton sound, numerous tertiary points were marked and plotted on a plane-table sheet, on which was afterwards traced in a large portion of the irregular shore-line forming the western side of Chandeleur sound. This was done with the plane-table at intervals which

would not admit of observations on the longer lines of the triangulation. The work being in that manner completed some distance southward, the vessel was moved to Isle au Breton sound for more convenient access to the stations remaining to be occupied. In addition to the angular measurements in that vicinity and others at stations connecting with the triangulation of Chandeleur sound, a second plane-table sheet, commenced in 1857, was completed in the course of the season which closed in the latter part of May.

The reconnaissance made by Sub-Assistant Harris extended over an area of about two hundred and thirty square miles. He thus reports the statistics of the triangulation:

Stations occupied	12
Signals erected and stations marked	28
Objects observed on	41
Angles measured	110
Number of observations	1,770
Area of triangulation, (square miles)	180

The Würdemann theodolites, ten inch, No. 79, and six inch, No. 84, were used at the stations.

One hundred and fifteen miles of shore-line were traced and marked on the two plane-table sheets.

Great care was taken in regard to the triangulation points; and in reference to the means most proper for their preservation, Mr. Harris observes: "Having noticed the causes which led to the destruction of some of the stations, I adopted precautions in the following particulars: 1. The selection of stable ground not likely to be exposed to the action of water. 2. The use of a number of marks for each station, situated at such distances from each other and under such different circumstances, as to make it unlikely that all will be displaced by the same cause. 3. Distinguishing and determining each mark so that it may be recognized and its position known in case of the loss of all the other marks at the same station. 4. Making all the marks entirely separate from the observing tripods and scaffolds."

Full descriptions of the stations and signals used this season, and of the marks placed to identify them, have been made by Mr. Harris and placed in the office. He has also turned in his computations and records of the previous year.

The field operations of the party were aided by Mr. R. E. Halter, who executed the greater part of the plane-table work, and by Mr. H. W. Bache.

After his return to the office, Sub-Assistant Harris engaged in the computations depending on the work of the season.

Triangulation of the Mississippi delta, La.—In continuation of the work in this quarter, Assistant F. H. Gerdes resumed operations at the opening of the year, and prosecuted the survey of the delta until the middle of March. He was assisted by Sub-Assistant J. G. Oltmanns and Mr. G. U. Mayo. After replacing and determining the positions of the signals displaced by recent storms, Mr. Gerdes reoccupied six of the secondary stations, and connected with the general scheme of triangles a number of tertiary points suitable for the plane-table survey of Southeast Pass, Pass à l'Outre, the North Pass, the mud flats in that vicinity, and Robinson's reef, together with the shores of Bay Rondo, and the banks of the Mississippi at the head of the passes. The plan of the work, as far as executed, may be seen by reference to Sketch No. 26. Notice of the topographical survey will be taken in a subsequent part of this chapter.

The statistics of the triangulation are as follows :

Signals erected	29
Stations occupied	12
Angles measured	74
Number of observations	1,264

In my report of last year allusion was made to the difficulty of finding localities on the delta in which the station-marks could be secured. Assistant Gerdes reports that the peculiar obstacles arising from the nature of the surface increase on advancing towards the outlets, the soil being too unstable to admit of any ordinary expedients for guarding against their removal or displacement. Though insufficient in number and in their distribution as points for future reference, the light-houses and a few buildings with cupolas, being determined in position and connected with the triangulation, in some measure lessen the natural disadvantages under which the survey is advancing in this part of the section.

On closing for the season at the delta, Assistant Gerdes transferred his party to Pensacola, and took up the survey in that vicinity, described under the head of Section VII.

In the course of the summer the records of the triangulation of the delta were duplicated and turned in, with abstracts of the measurements for secondary and tertiary work.

Triangulation of West Côte Blanche bay, La.—Towards the end of March Sub-Assistant Oltmanns having reached his working ground, in the schooner Gerdes, from the delta of the Mississippi, where he had been occupied during the winter in the party of Assistant Gerdes, placed himself in communication with the hydrographic party, and furnished the data necessary for sounding out the western part of Atchafalaya bay. On taking up the triangulation it was found that nearly all of the stations westward of Point au Chevreuil had been disturbed by natural causes. Some of the stations which had been marked with the usual care were entirely lost, and neither of the blocks placed to distinguish the ends of the base on Point au Chevreuil could be found. Mr. Oltmanns resumed work at the line Marsh island, North —— Point Malone, (Sketch No. 26,) and extended the triangulation over the greater part of West Côte Blanche bay, including also Côte Blanche island. All the stations were well secured by screw piles, or by surrounding marks deemed sufficient for their preservation.

One of the hindrances to progress in the prosecution of the survey on this part of the coast arises from the shoaling of the water in going westward. The bay, however, narrows in that direction, and Sub-Assistant Oltmanns reports, as the result of his reconnaissance, that the triangulation may, with lessening difficulty, be carried into and across Vermilion bay.

The following is a synopsis of the field statistics :

Stations erected	10
Stations occupied	7
Points determined	12
Angles measured	31
Number of observations	289

The work in Côte Blanche bay was discontinued for the season on the 1st of May. In its progress Mr. Oltmanns provided means for executing the plane-table survey, which will be referred to presently.

The observations and computations resulting from them have been furnished in detail for the records of the office.

Topography of Lake Pontchartrain, La.—Steady progress has been made in pushing the plane-table survey westward from the connection between Lake Borgne and Lake Pontchartrain. Sub-Assistant W. S. Gilbert proceeded from his former limits in that quarter on the 17th of January, and laid out two sheets to contain the features of the northern shore of Lake Pontchartrain. Two others were at the same time projected for extending the work along its southern shore westward from Chef Menteur. On the most eastern of these the shore-line and adjacent features of the north side of the lake were filled in beyond Bayou Bonfouca, the lower part of that bayou and its branches being also followed and included with the topographical details. Further westward, (Sketch No. 26,) and on the same side, the shore-line was traced as far as Ragged Point. The line of woods ranging with the water line was chosen as the limit for the minute survey.

From Chef Menteur, on the southern side of Lake Pontchartrain, the detailed work was continued southward and westward to Little river, and in the same direction the shore-line survey extended to the Jefferson railroad. The limits of the several sheets are marked on the progress sketch No. 26, on which is also shown the line of junction with the work of last season.

In prosecuting the survey on the north shore of the lake, it was found, in many cases, necessary to build stations for the plane-table, the ground passed over being soft marsh. With regard to its general character, the remarks made in my previous annual reports, in reference to the district between Lakes Borgne and Pontchartrain, apply also to the tract under notice.

The following are aggregates of the outline and detailed work of this season:

Shore-line surveyed	164 miles
Area of topography, (square miles)	49

Sub-Assistant Gilbert was aided during the early part of the year by Mr. R. E. Evans. The field-work was continued until the 13th of June, and the latter part of the summer occupied by Mr. Gilbert in inking his sheets.

Topography of the Mississippi Delta, La.—While engaged in the triangulation, Assistant F. H. Gerdes projected a plane-table sheet for the survey of Bay Rondo and the northern part of the delta, and determined the points necessary for filling in the details. About two-thirds of the area intended to be represented now appears on the sheet, progress on which was made as the triangulation advanced. Both shores of the Mississippi at the head of the passes, and from thence eastward the shores of the main outlet, with its two branches, the Southeast Pass to the Belize, and the entire course of Pass à l'Outre, were surveyed. The sheet, as marked on Sketch No. 26, contains also the mud flats in the vicinity of the North Pass, part of the details of the system of lagoons existing to the westward of it, and those of Robinson's reef, on the north side of Bay Rondo.

Mr. Gerdes thus remarks on the local characteristics of the eastern part of the delta:

"With the exception of the Gulf shore, which, north of the delta, is open and composed partly of beach and hard marsh, the plane-table could be nowhere used, the cane and reeds growing so high as to prevent any sight for sketching in the details. In making the topographical survey, flags of distinctive shape or color were placed at each turn of the river and

its outlets, and their positions determined from two trigonometrical stations by the theodolite or sextant. At one reach several miles of the stream were surveyed by means of a signal hoisted on a boat and moved from point to point as occasion required, according to the method proposed by Mr. Norris. So far as opportunity has offered for verification, the details thus obtained have been found correct."

The unfinished portions of the sheet will contain the survey of some interior lakes, small bays, and bayous adjacent to the main eastern outlet of the delta. Of the work done, the following is a summary of statistics:

Gulf shore surveyed	16 miles
River shores surveyed	53 "
Shore line of bays and bayous	51 "
Area, (square miles)	50

Sub-Assistant J. G. Oltmanns and Mr. G. U. Mayo aided in the triangulation and topography.

Assistant Gerdes found advantage in his labors at the delta through the interest manifested by the inhabitants generally in regard to the progress of the survey. He acknowledges also the facilities and assistance rendered to his party by the Pilot Association of the Belize.

Part of the plane-table duty conducted by Mr. Gerdes has been noticed with the work done in Section VII.

Topography of West Côte Blanche bay, La.—Following his own triangulation of this season, Sub-Assistant Oltmanns surveyed the shore which fell within its limits, as shown on Sketch No. 26, and included also the northeastern part of Marsh island. The plane-table sheet contains an aggregate of about forty-eight miles of shore-line.

An extract from the report of Mr. Oltmanns, descriptive of the topographical features of the vicinity of Côte Blanche bay, is here appended:

"The shores are all very marshy, excepting those of Côte Blanche island. Marsh island is so soft and swampy that the utmost care must be taken in setting up an instrument. Its shores are subject to frequent and rapid changes. Of late years the island has been cut through in several places, and the interior lakes and bayous are changed or enlarged by almost every storm."

"The northern shore of the bay, from Côte Blanche about two miles eastward, and westward about eight miles, or as far as Dead Cypress Point, consists of hard clay and is very little broken."

"Côte Blanche island, like Belle Isle, is one of those remarkable formations of firm land standing out at intervals along this part of the coast of Louisiana from surrounding marshes. It is about a hundred and twenty feet high, and contains an area of, perhaps, two thousand acres of land, on which are raised sugar-cane, cotton, and tobacco."

Having passed the working season at two localities in this section, Mr. Oltmanns sailed for Pensacola, and, after reporting to Assistant Gerdes, proceeded eastward with the vessel and reached New York on the 12th of June.

Soundings in the Rigolets, La.—At an interval in his plane-table duty, in February, Sub-Assistant W. S. Gilbert thoroughly sounded out the entire course of the principal passage from Lake Borgne to Lake Pontchartrain, and kept records of the tides while his party was so engaged. Specimens of the bottom were taken on most of the traverse lines, so as to supply full information in regard to the character of the bed of the channel. The tidal

observations developed only a slight variation in the water level, amounting in rise to no more than seven inches in twenty-four hours, and often only four inches and a half. A strong current at that time passed constantly out of Lake Pontchartrain during both rise and fall of the tide.

Hydrographic reconnaissance of Pass à l'Outre, Mississippi delta.—The party of Lieut. Comg. T. B. Huger, U. S. N., Assistant Coast Survey, arrived at the delta on the 15th of May, having been previously employed with the steamer Walker in the western part of the section. A tide-gauge was at once set up at the revenue station and a careful reconnaissance made of the entire course of the Pass à l'Outre from its head, in the Mississippi, to the bar. The vessel then proceeded eastward, taking a line of deep-sea soundings across the Gulf in the direction to Havana.

The reduction from the chart of soundings made in Pass à l'Outre, under the direction of Lieut. Comg. Huger, comprises also the plane-table work executed by Assistant Gerdes.

The hydrographic statistics are as follows:

Miles run in sounding	51¼
Angles determined	343
Number of soundings	1,719

Hydrography of Atchafalaya and Côte Blanche bays, La.—The hydrography of Atchafalaya bay has been completed by supplementary soundings carried westward from the limit reached last year by the party in the steamer Walker. In order to facilitate his operations, the draught of the vessel not admitting of her general use in sounding, Lieut. Comg. Huger established a camp about sixteen miles distant from his anchorage, at the entrance of Bayou Salé, Côte Blanche bay, or nearly midway between Point au Chevreuil and Point Malone, (see Sketch No. 26.) A second party was detailed to work from the ship. Under this arrangement, after joining on the line to which the work had been extended by Commander B. F. Sands, and setting the necessary signals and tide-gauges, the soundings were continued westward into Côte Blanche bay, with only the impediments due to the frequent recurrence of bad weather. The two divisions of the party were occupied in this duty between the 27th of January and the 14th of May, the latter part of that interval being devoted to the hydrography of the approaches to Atchafalaya bay.

A summary of statistics derived from the records turned in by Lieut. Comg. Huger is given below:

Miles run in sounding	743
Angles measured	2,539
Casts of the lead	69,447

The soundings in this part of the section now include the whole of the Atchafalaya and Côte Blanche bays east to the line joining East Point, on Marsh island, and Point Malone.

Before the close of his connection with the survey, at the end of last year, Commander Sands turned in the original sheet and journals of the soundings, angles, and tidal and current observations pertaining to the final service of his party in Atchafalaya bay. The chart containing the results of the present season, with the original note-books and hydrographic records, have been received from Lieut. Comg. Huger.

In returning from this section the deep-sea line was used by the party in the steamer Walker for Gulf soundings between the Mississippi delta and Key West, and in verifying soundings made last year between the Tortugas and Havana.

SECTION IX.

FROM VERMILION BAY TO THE BOUNDARY AT THE RIO GRANDE, INCLUDING PART OF THE COAST OF LOUISIANA AND THE COAST OF TEXAS.—(SKETCH I, No. 28.)

The following operations have been in progress by the parties in this section:

1. Triangulation of Espiritu Santo, San Antonio, and Aransas bays, Texas.
2. Topography of Espiritu Santo and San Antonio bays, Texas.
3. Hydrography of Matagorda bay, Texas.

Office-work.—The reconnaissance sketch of the entrance to Brazos river has been drawn and engraved, and progress has been made in the drawing and engraving of coast maps and charts Nos. 106 and 107, from Galveston bay to Matagorda bay; also in the drawing of coast maps and charts No. 105, Galveston bay, and No. 108, Matagorda bay. A general reconnaissance sketch of part of the coast of Texas, from Matagorda bay to Aransas Pass, has been drawn at the office, and was engraved on stone, under the direction of the Superintendent of Public Printing.

Triangulation of Espiritu Santo, San Antonio, and Aransas bays, Tex.—The experience of previous seasons on the coast of Texas having indicated the opening of the calendar year as the most favorable period for taking up field operations, Assistant S. A. Gilbert organized a party and reached the limit of his completed triangulation, to the southward of Matagorda bay, on the 5th of January. For the extension of the work towards Aransas Pass, a close reconnaissance had been made, as stated in my last annual report, which was accompanied by a reduction from the resulting sheet, marked as Sketch No. 28. Such of the signals then erected as required adjustment were properly secured, and others were set to replace those which had been destroyed by accidents of the weather in the course of the preceding year. The scheme fixed on for the triangulation took in the lower part of Espiritu Santo bay, the shores of San Antonio bay, including its upper waters, known as Mission bay and Hines bay; in connection with it, to the southward and westward, Mezquit bay, and beyond that, in the same direction, the shores of Aransas and Copano bays with their dependencies. These several bodies of water are formed, as may be seen on the progress sketch No. 28, by the intervention of Matagorda island and St. Joseph's island between the main coast of Texas and the Gulf of Mexico. The most eastern of the stations occupied for the triangulation range along the outer or Gulf shore of the two islands just named, the lines from them crossing the several bays before enumerated, and terminating at stations on the main.

Assistant Gilbert continued in the field until the 9th of June, having then pushed the triangulation about forty-eight miles southward and westward from the starting point in Espiritu Santo bay. A summary given in his report shows the following statistics of work done within the season:

Stations occupied	32
Points determined in position	66
Angles measured	180
Number of observations	3,392

The triangulation covers an area of about six hundred and fifty square miles. Some of the requisite signals were erected, and a partial reconnaissance made for continuing the work over Corpus Christi bay; but the summer winds set in so strong before the party was disbanded as to render further progress in triangulation impracticable for the present year.

Mr. Gilbert was efficiently aided in the field by Mr. Charles Hosmer, who also rendered good service in making computations of the results, and in duplicating the records of the observations, all of which have been turned in at the office.

The following reference is made in the season's report to the general features of the site of work: "The character of the country we were engaged upon is more diversified than any other portion of the coast of Texas over which my operations have yet extended. Low sandy islands, varying from one to four miles in breadth, stretch along the Gulf coast, with sand hills upon them from ten to forty feet in height. These range along the outer shore, and occupy a space from a quarter to half a mile in width. A fine prairie, averaging three-quarters of a mile in breadth, slopes gradually to the marsh and bare sand flats that form the bay shores. The islands afford an excellent range for cattle, sheep, and horses, there being amongst the sand hills and in the sinks of the prairie an abundance of fresh water, except in the dry season of the year. During all seasons fresh water may be had by digging anywhere among the sand hills, or in the high prairie, in the strata immediately above the level of the surrounding salt water."

"The sheets of water lying between these islands (Matagorda and St. Joseph's) and the main are divided by chains of other islands, by oyster shell reefs, or by the configuration of the shores, into four large bays: Espiritu Santo, San Antonio, Copano, and Aransas bays; and six smaller: Mission, Hines, Mezquit, St. Charles, Refugio Mission, and Puerto bays." Of each of these a general description is contained in the report of Assistant Gilbert, extracts from which will be found in the Appendix, (No. 32.) I must here commend the character of this report, which is so well adapted to the circumstances of the country through which Mr. Gilbert's work was carried.

The original journals containing the notes of horizontal angles and an abstract of the geographical positions determined by the triangulation, have been received at the office.

Topography of Espiritu Santo and San Antonio bays, Tex.—The plane-table work in this section was prosecuted by a party in charge of Sub-Assistant W. H. Dennis. After completing the survey of the city of Indianola, as supplementary to one of the sheets executed last season by Sub-Assistant M. Seaton, Mr. Dennis moved his party to Matagorda island, and there joined with the topographical limits of Assistant Gilbert, who, as already stated, has been more recently engaged in pushing the triangulation of the coast of Texas towards Corpus Christi. Of the three plane-table sheets projected by Mr. Dennis, two were entirely filled and the other partly completed. These include a stretch of twenty miles coastwise, and represent the whole breadth of the middle parts of Matagorda island, the shores of the lower part of Espiritu Santo bay, Mission and Hind's bays, and the shores of the greater part of San Antonio bay, with the mouth of its principal tributary, the Guadalupe river. The limits of the several sheets are marked on Sketch No. 28. In general, the surface of the country passed over by the party favored operations with the plane-table, the marsh being tenable, and the fast land mostly level prairie. The only impediment found is thus alluded to in the season's report: "The survey of Mission bay, with the point extending from it into San Antonio bay, was attended with some difficulty, the shores being covered with canebreak some twenty feet high and nearly

impenetrable." Sub-Assistant Dennis took the field on the 15th of December, and closed work on the 30th of May. A summary of the plane-table statistics is appended:

	Miles of shore-line.	Miles of bayous, ponds, &c.	Miles of marsh line.	Miles of roads.	Area, square miles.
Indianola and vicinity	4.0	1.5	7.0	4.7	3.0
Sheet No. 1	84.3	69.0	62.0	3.5	43.0
Sheet No. 2	42.5	19.0	13.0	8.0	38.0
Sheet No. 3	12.5	21.7	17.5	1.8	12.0
	143.3	111.2	99.5	18.0	96.0

Mr. T. C. Bowie served as aid in the topographical party.

The report of Sub-Assistant Dennis contains the following remarks relative to the natural features presented on the shores of San Antonio bay: "There is very little timber land within the limits of the work of this season, excepting on the banks of the Guadalupe river, which has a narrow strip of oak, cedar, etc., on either side. The water at the mouth of that river is fresh, and when the stream is high the fresh water extends nearly to the first chain of islands. The mouth of the Gaudalupe has been dredged out, and a channel has been made through the first chain of islands, by which a steamer from Indianola regularly passes to a landing forty or fifty miles up the river."

Sub-Assistant Seaton has inked and placed in the archives the sheets containing his surveys of last year on the shores of Lavaca, Garcitas, and Chocolate bays. The supplementary sheet showing the vicinity of Indianola has also been turned in.

In July Sub-Assistant Dennis was assigned to topographical duty in Section I.

Hydrography of Matagorda bay, Tex.—It has been mentioned in a previous chapter that the hydrographic work allotted to be done in this section was assigned for the latter part of the working season to the party of Lieut. Comg. J. K. Duer, U. S. N., Assistant Coast Survey, the former part being occupied in Section VII. The steamer Vixen, in accordance with this arrangement, arrived at Matagorda on the 19th of April, and at once took up work on the inside of the peninsula, in the immediate vicinity of the city, and between that date and the 3d of June sounded out the portion of the bay which is comprised between lines crossing from the peninsula to the main at Matagorda and Palacios Point. The reach referred to is about sixteen miles in length, by nearly five in average breadth.

Sketch No. 28 shows its location, and the limits of the sheet containing the hydrography.

This work was done under the direction of Mr. A. W. Muldaur, in the absence of Lieut. Comg. Duer, who returned to Section VII immediately after the arrival of the party in Section IX, and died at Apalachicola on the 14th of June, as already stated. The particulars in regard to this untimely event, and the measures taken for the subsequent disposal of the party and vessel, have also been mentioned.

A summary furnished by Mr. Muldaur at the end of the season gives the following statistics of work executed in Matagorda bay:

Miles run in sounding	451
Angles determined	919

Number of soundings	33,135
Tidal stations occupied	3

The sheet embracing the hydrography here referred to has been received at the office in Washington.

SECTION X.

WESTERN COAST OF THE UNITED STATES, FROM SAN DIEGO NOTHWARD TO THE FORTY-SECOND PARALLEL, INCLUDING THE COAST OF THE STATE OF CALIFORNIA.—(SKETCHES J AND J BIS, NOS. 30 AND 31.)

The usual number of parties has been employed in this section, and their progress is described under the following heads:

1. Primary triangulation near San Pedro, Cal.
2. Triangulation of Santa Rosa island, Cal.
3. Triangulation and topography of San Pedro harbor, Cal.
4. Primary and secondary triangulation north of San Francisco, Cal.
5. Latitude and azimuth.
6. Triangulation of Crescent City harbor, Cal.
7. Topography of Santa Cruz island, Cal.
8. Topography of Crescent City harbor, Cal.
9. Hydrography of San Pedro harbor, Cal.
10. Soundings off the Golden Gate entrance to San Francisco bay, Cal.
11. Resurvey of Humboldt bay, Cal.
12. Hydrography of Crescent City harbor, Cal.
13. Tidal observations.

The primary work, which for some years has not made progress proportional to its former development, has this year been placed in the hands of Assistant George Davidson, whose well-known zeal, and energy, and skill have all been shown in its prosecution, so that the advance has been entirely satisfactory, under difficulties which have required all his resources to surmount.

The resurvey of San Pedro and Crescent City harbors was called for in consequence of the improvements made or contemplated in those localities and in the back country which finds access to the sea at those ports.

Office-work.—The engraving of the charts of San Diego bay, the entrance to San Francisco bay, Mare Island straits, and Humboldt bay, has been finished. Progress has been made in the engraving of the chart of San Pablo bay, and additions have been made to the sheets of Alden's reconnaissance of the Western Coast. The map of San Francisco city has been engraved on stone, under the direction of the Superintendent of Public Printing.

Primary triangulation near San Pedro, Cal.—In adjusting the triangulation along the coast of the Santa Barbara channel, it was found necessary to reöccupy several of the stations connecting with the preliminary base measured near San Pedro. This duty was performed by Assistant W. E. Greenwell, between the 5th of November, 1858, and the 6th of March following.

The revised triangles are laid out on Sketch No. 30. On being tested in the usual way they were found to close within the limits allowed for general accuracy.

A synopsis of the statistics is appended:

Signals erected	8
Stations occupied	6
Number of observations	2,268

The horizontal angles were measured with the eight-inch Gambey theodolite, C. S. No. 44.

Mr. Greenwell used the schooner Humboldt for this and other service performed in the section.

Duplicates of the notes of horizontal angles observed in the primary work of last year have been furnished for the records of the office.

Triangulation of Santa Rosa island, Cal.—This work was commenced by Assistant Greenwell on the 8th of June, by the measurement of a short base on the northern part of the island, the location of which may be seen by reference to Sketch No. 30. The triangulation, as far as completed at the end of August, embraces the northern half of the area of Santa Rosa, and the work was then in active progress. Strong northwest gales prevailed between the dates mentioned, tending very much to retard the advance of field operations.

A summary of the statistics is thus given in the report of Mr. Greenwell:

Signals erected	13
Stations occupied	8
Number of observations	1,120
Area of triangulation, (square miles)	18

The schooner Humboldt was in the service of the party at Santa Rosa island.

Assistant Greenwell has sent in duplicates of the observations recorded in the triangulation of San Miguel and San Nicolas islands, and notes of the measurement of the preliminary base on Santa Cruz island.

Triangulation and topography of San Pedro harbor, Cal.—This duty was executed by Sub-Assistant W. M. Johnson, and the data necessary for the hydrography furnished to Commander Alden.

The scheme of triangulation laid out to include the shore of the harbor at San Pedro is shown on Sketch No. 30. With the view of following at once with the plane-table survey the necessary points were determined while the preliminary work was going on. Mr. Johnson then projected a sheet and pushed on the topography to completion. The sheet containing his survey embraces an area of about thirteen square miles, over sixty miles of shore-line, and nineteen miles of roads.

Sub-Assistant C. M. Bache was attached to the party.

The triangulation embraced nine triangles within an area of fifteen square miles. Four hundred and eighty-six observations were made in the measurement of angles.

Primary and secondary triangulation north of San Francisco, Cal.—This work and the astronomical observations connected with it were taken in charge by Assistant George Davidson on the 14th of November, 1858, immediately after his return to the Western Coast. In the primary triangulation Table mountain, a precipitous height which rises from the shore of Ballenas bay, and Sulphur Peak, a high mountain well up the course of Russian river on its eastern side, were occupied as stations with the theodolite, and horizontal angles measured so as to complete, with the exception of Ross mountain station, the coast series of triangles from Monterey and over San Francisco bay to the last-mentioned point, the position of which may

be seen on Sketch No. 31. At Mount Diablo, one of the primary stations in the general scheme and in immediate connection with Table mountain, the labor and expense of transporting a solid signal to the summit, which is 3,800 feet above the nearest dwelling, were obviated by Mr. Davidson, who thus describes the expedient employed for that purpose: "The signal was constructed at San Francisco, and consisted of six pieces of two-inch Oregon pine fitted to six appropriate inside bearings, so that, when put together, the whole presented externally the appearance of the frustrum of a cone thirty-five feet high, with a diameter of fifteen inches at the base and ten at the top. The separate pieces and their bearings, being previously provided with screws, were carried up the mountain and fastened together in half an hour. Stout iron bands were driven on to bind all the pieces firmly together, and the hollow shaft was then set and secured in its proper position. Even with the advantage of the method employed, the handling of the parts of the signal in passing to the summit proved to be very hard labor. If the cañadas of the mountain side had afforded a solid piece of timber of similar outside dimensions, no available power could have taken it up." Vertical angles were measured from the station on Table mountain, and also from that on Sulphur Peak.

Ross mountain, which lies near the coast and a few miles north of the mouth of Russian river, will be occupied next in order by the party of Assistant Davidson.

The secondary and tertiary triangulations, extended this season over Drake's bay and Point Reyes are also shown on Sketch No. 31, and from Table mountain, Point Reyes Hill, and Point Reyes Head, horizontal angles were measured to determine the positions, extent, and heights of the islets which form the middle and north groups of the Farallones.

The reconnaissance necessary in advance of occupying stations for the primary and secondary work was made by Mr. E. H. Fauntleroy, one of the aids in the party. At the date of Assistant Davidson's report Mr. Fauntleroy, in conjunction with Mr. A. T. Mosman, who was detailed as an aid to this party in June, were reconnoitering the tract lying northward and westward of Sulphur Peak. The privations to be borne in the performance of such duty over a country naturally wild and rugged, and totally devoid of facilities for travel, are very great. The labors of the triangulation party in pushing the work to its present limit, as set forth in the report of Mr. Davidson, have been attended with unusual hardships and difficulties.

The following is a synopsis of the season's progress in triangulation:

Number of signals erected	18
Primary stations occupied	2
Secondary and tertiary stations occupied	5
Horizontal angles measured	73
Vertical angles	15
Observations for horizontal angles	4,624
" " vertical "	1,348

Work in the field was carried on from the 10th of January until the close of September.

Latitude and azimuth.—The latitude of Sulphur Peak primary station was determined by Assistant Davidson by three hundred and thirty-one observations on ninety-four stars; and the azimuth at that point and at Table mountain by five hundred and sixty-four observations. At the same stations three hundred and one observations were recorded for local time, and ninety-eight at Sulphur Peak for determining the value of the micrometer threads.

Observations were made at Table mountain for ascertaining the reading of the level scale

divisions of the vertical circle No. 80. Those of the levels A and B of zenith telescope No. 3, and of level A of transit No. 2 were determined at Sulphur Peak by using the vertical circle No. 28, and a hundred and sixty-two observations were made for that purpose.

In the ensuing season Ross mountain will be occupied as an astronomical station.

Meteorological journals were kept while the party was employed in the field.

Ten volumes, containing the original records of the triangulation and astronomical observations, and seven others, duplicates of the same, have been received from Mr. Davidson. His computations depending on the original notes of the work have been completed.

The journals kept by Assistant G. A. Fairfield while the work north of San Francisco was under his charge have been filed at the office.

Triangulation of Crescent City harbor, Cal.—This duty was executed under special directions in April, by the party of Sub-Assistant J. S. Lawson, before taking up the general field-work to which it had been assigned in the adjoining northern section. A preliminary base was laid out in front of Crescent City and measured twice with a twenty-metre chain, previously adjusted for that particular purpose. The measurements gave a mean result of 1,018.6 metres for the length of the line. Stations were then erected at intervals along the coast from a point a mile west of the light-house to another four miles to the eastward of Crescent City, and on all the prominent rocks in the harbor. Twelve signals were set up and sixty objects in all observed on in determining the angles. In addition to these, readings were taken on a hundred and fifty objects, the results of which, as determining them in position, were computed at once and plotted for use in the topographical survey. Sketch No. 31 gives a plan of the completed triangulation. The following is a synopsis of the statistics:

Stations occupied	8
Angles measured	75
Number of observations	1,176

The six-inch Gambey theodolite, C. S. No. 21, was used in measuring the angles. Mr. Alexander Agassiz served as aid in the party, which was charged also with the plane-table survey of Crescent City harbor.

A duplicate of the record of horizontal angles observed by Sub-Assistant Lawson is now on file at the office.

Topography of Santa Cruz island, Cal.—The survey of this island was resumed by Sub-Assistant W. M. Johnson, after completing field-work at San Pedro, of which notice has already been taken in the former part of this chapter, and has been prosecuted along the north shore so as to include Prisoner's harbor and Chinese harbor, with only such interruptions as are incident to its exposed position. The report of Mr. Johnson states that there are but three places on the island available as centres for working, by reason of the great difficulty of procuring wood and water, and that great impediments are found in the violent northwest winds, which set in daily at 10 a. m. during summer and continue until sunset. The progress made is shown in the following statistics:

Shore-line traced	35½ miles.
Roads surveyed	18¾ "
Area of details, (square miles)	16

Sub-Assistant C. M. Bache assisted in the survey.

The position of Santa Cruz island is shown on Sketch No. 30.

Topography of Crescent City harbor, Cal.—The triangulation requisite for the plane-table survey and hydrography was made, as already stated, by Sub-Assistant J. S. Lawson, in April. Having provided a sufficient number of points, Mr. Lawson traced, in the shore-line of the harbor and the adjacent coast from Hall's bluff west of the light-house, as seen on Sketch No. 31, to the eastern limit of the triangulation, or about four miles eastward of Crescent City.

"Especial care was taken to determine the position of every rock bare at low water. Between Battery Point and Preston's island many of the plane-table stations were reoccupied as near the time of low water as possible, for securing accuracy of details in that respect."

A tracing from the working sheet was promptly made and furnished to the hydrographic party of Commander Alden. The original was soon after inked and sent to the office with the following memorandum of statistics:

Shore-line surveyed	8.2 miles.
Roads	3.5 "
Area of details, (square miles)	1.7

After completing the survey at Crescent City the party returned to San Francisco, and at the usual period of the year sailed with the brig Fauntleroy to carry out the general instructions for work in Section XI. Sub-Assistant Lawson was accompanied by Mr. Alexander Agassiz as aid.

Hydrography of San Pedro harbor, Cal.—As part of the regular work of the season, the anchorage at San Pedro and its vicinity were sounded out anew by the party of Commander James Alden, U. S. N., assistant Coast Survey, with the steamer Active. Sketch No. 30 shows the limits of the sheet, which was projected so as to include the hydrography of the approach eastward and southward by Point Fermin.

The resulting chart (Sketch No. 32) verifies the soundings made in the reconnaissance of 1852, and in reference to it Commander Alden says: "The bar at the entrance to the creek remains about the same. At mean low water, throwing out the half tides, only two feet of water can be carried over it. The steamer Active could go in easily at high water."

Sub-Assistant Johnson traced the shore-line for the use of the hydrographic party.

The following is a summary from the journals of soundings and angles:

Miles run in sounding	209
Angles measured	1,208
Casts of the lead	5,866

Soundings off the Golden Gate, entrance to San Francisco bay, Cal.—At favorable intervals during the winter of 1858–'59 the hydrography outside of San Francisco bar was executed by the party of Commander Alden, with the surveying steamer Active. The work was extended about thirty miles abreast of the entrance, as measured from Point Reyes southward and eastward along the line of junction with the soundings carried from the inside of the bar in 1854. From the bar, broad off to seaward, the hydrography now extends about twenty-five miles westward, or five miles beyond the meridian of the Farallones. The limits of this work are marked on the Progress Sketch No. 31. In making the soundings sixty-three specimens of bottom were brought up from different localities of the space passed over by the vessel. The following is a summary taken from the hydrographic records:

Number of angles observed	1,369
Casts of the lead	722
Miles run in sounding	694

The survey of the approaches to the Golden Gate was essentially completed by the end of February.

Resurvey of Humboldt bay, Cal.—On the upward passage of the steamer Active for duty in the adjoining northern section, Commander Alden incidentally made a resurvey of Humboldt bay above and below the entrance, as shown on Sketch No. 31. The soundings were taken between the 11th and 22d of July, and were applied in completing the chart which accompanied my last published annual report as Sketch No. 31.

The statistics of the resurvey are as follows:

Miles run in sounding	119
Angles observed	1,094
Number of soundings	5,221

Sub-Assistant J. S. Lawson made the plane-table survey in a previous season.

The original sheet containing the soundings last made is now at the office.

Hydrography of Crescent City harbor, Cal.—This work was based on the triangulation and topography executed in the early part of the year, as already detailed. The soundings were made in July by the party of Commander Alden in the surveying steamer Active.

In reporting on the completion of the hydrography, Commander Alden remarks: "During the progress of the survey of Crescent City harbor we found several new and dangerous rocks, but as they are not lying immediately in the channels followed by the steamers, and do not interfere with the anchorage in use, it does not seem necessary to notice them further in advance of the publication of the chart, as every one now trading there knows that vessels drawing over nine feet should be very cautious in venturing out of the beaten track. The rocks at that place are of a peculiar character, standing isolated like bayonets, with their points just below the surface, and ready to pierce any unlucky craft that may encounter them. After we finished the survey and I had selected a particular fair way for a sailing line, we discovered a very sharp rock almost directly in the passage, with its point only three feet from the surface, and deep water all around it. I mention this to show that although the greatest care was taken in the survey, the character of the points of rock is such that it cannot be surprising if a new one is found for several seasons to come. Still, by following the track which has been passed over so often by heavily laden steamers, no danger need be apprehended."

An engraved reduction from the sheets containing the survey of Crescent City harbor accompanies this report, as Sketch No. 33. The original chart is now at the office.

A summary of the hydrographic statistics is thus given in the report of Commander Alden:

Miles run in sounding	101
Angles measured	701
Number of casts of the lead	3,221

After completing this work the party in the Active proceeded to Section XI, under which head further notice will be made of its occupation.

Tidal observations.—Under an arrangement made several years ago satisfactory to the chief of the Engineer Bureau, and by which the services of Lieut. G. H. Elliot of that corps became available for the general supervision of the observations, the self-registering tide-gauges at San Diego and San Francisco have been kept in operation during the present year. Records have been received monthly showing that the series is successfully continued.

SECTION XI.

WESTERN COAST, FROM THE FORTY-SECOND PARALLEL TO THE NORTHWESTERN BOUNDARY OF THE UNITED STATES, INCLUDING THE COAST OF OREGON AND THAT OF WASHINGTON TERRITORY.—(SKETCH K, No. 35.)

The regular work of this section has necessarily given place to that connected with the boundary, and has been further impeded by the necessity for placing the hydrographic vessel, the steamer "Active," at the disposal of the War Department. (Appendix No. 36.)

The following work has been executed in this section, and is reported upon in this chapter:

1. Triangulation of the Gulf of Georgia, W. T.
2. Reconnaissance of Coquille river entrance, Oregon.
3. Hydrographic reconnaissance of Gray's harbor, W. T.
4. Tidal observations.

Office-work.—A new edition of the reconnaissance sketch of Washington sound, W. T., and the chart of Port Townshend have been drawn and engraved, and the engraving of the charts of Port Gamble and Semi-ah-moo bay has been completed.

Triangulation of the Gulf of Georgia, W. T.—The field-work in this section was confined mainly to the triangulation of the Gulf of Georgia, abreast of Point Roberts, and in the vicinity of the forty-ninth parallel of latitude, but owing to the prevalence of smoke in the atmosphere during the entire season the progress expected at its outset has not been made. Sub-Assistant James S. Lawson, who conducted the operations and improved every opportunity for advancing the triangulation, says, in allusion to the hindrance from this cause: "Thus far, during the present season, the weather has furnished another illustration of the experience of former years, that each alternate season is very dry, and consequently that the immense fires started by the Indians sweep over a vast extent of country, so that it is often impossible to see, at the same time, both shores of the channels. During the last three months of the working season of 1857 we were often anchored within a quarter of a mile of the shore and could not see it. Last year was just the reverse, owing to the quantity of rain that fell tending to extinguish, or at least retard, the progress of the fires." * * * * * *

"In carrying the work forward from the limits of last year, I laid out a scheme of triangulation which seemed the very best that the conformation of the country would allow, as it tended to carry the work to the forty-ninth parallel with the least number of triangles. The lengths of the sides, however, were too great for observing on through the smoky atmosphere, and I have been compelled to change the plan and adapt my operations to circumstances."

The stations occupied or observed on by Mr. Lawson, as will be seen by reference to Sketch No. 34, range along the northern shores of the chain of islands bounding the Gulf of Georgia, from Patos island westward to a station on the upper part of Galiano island. These connect by lines with several stations established on Point Roberts, the positions of which are marked on the Progress Sketch.

The following is a summary of the statistics of the season:

Signals erected	9
Signals of former seasons adjusted	13
Stations occupied	12
Objects observed on	46

Angles measured	36
Number of observations	1,948

The horizontal angles were measured with the ten-inch Gambey theodolite, C. S. No. 20.

Vertical angles also were measured by Mr. Lawson, and a hundred and thirty observations recorded for determining the height of the two summits of Mt. Baker, and that of the limit of snow. The snow range was computed by Mr. Alexander Agassiz, the aid in the party, to be at an elevation of 3,145 feet.

A further remark made by Sub-Assistant Lawson, in his report, refers to one of the most perplexing hindrances found in prosecuting the triangulation in the northern part of this section: "A necessary result of such a state of the atmosphere as that which I have mentioned is a remarkable range in refraction, but in no case have I ever seen it equal to what was experienced at the last station occupied. In one of the angles there was a range of 41″.3 in the various sets of observations, and in each of two others the range was as much as 35″.7. This large refraction occurs almost invariably at times when, during the whole or part of the day, the atmosphere has become remarkably clear and when the signals show very plainly and steadily. There is then no way of discovering the refraction except from the observations themselves. Usually it shows itself by the distorted appearance of the shores."

Copies of all the plane-table sheets traced by Mr. Lawson during last season were furnished to the commissioner on the northwestern boundary, Archibald Campbell, esq. The originals are now at the office.

The mark at the southern end of the base on Lummi island having been washed from its place by a gale in the winter of 1857–'58, Sub-Assistant Lawson occupied the stations connecting with it, and took suitable means for re-establishing the mark. He is now supplied with the improved apparatus described in my annual report for 1857, and having already graded and leveled the site of the base, the line will be remeasured as early as practicable in the ensuing season.

A meteorological register was kept, while the party was at work, of barometer readings, temperature, kind and amount of clouds, direction and force of the wind, and a record of the quantity of rain.

The duplicates of field notes were made, and abstracts and computations of the triangulation kept up to date as the work advanced. Those connected with the operations of last year are now at the office.

Four volumes, containing the recorded meteorological observations made in this section in previous seasons, have been turned in by Assistant George Davidson.

The brig Fauntleroy was used by Sub-Assistant Lawson for transportation and quarters in the Gulf of Georgia. At the close of the working season the vessel returned to San Francisco.

Reconnaissance of Coquille River entrance, Oregon.—With a view of making a hydrographic examination of the bar and channel of the Coquille river, Commander James Alden, U. S. N., assistant in the Coast Survey, attempted the entrance with the steamer Active, on her downward passage from his field of duty in connection with the Northwestern Boundary Commission, and found it, as was expected, inaccessible for vessels of ordinary draught. An accident to the centre shaft of the steamer, while in that vicinity, made it indispensable for the safety of the vessel that her voyage to San Francisco should not be at that time delayed.

The purpose of Commander Alden is to approach the Coquille entrance by land from Port

Orford, before the close of the year, if practicable, and to make a reconnaissance and soundings so as to fully determine the character of the river as a harbor of entrance.

Hydrographic reconnaissance of Gray's harbor, W. T.—In laying out the programme for the season's operations in this section, it was expected that the only field party for which the means are available might probably complete the special duty enjoined, in connection with the survey for the commissioner on the northwestern boundary, in time to admit of taking up the triangulation and topography of Gray's harbor within the present surveying year. This expectation, in consequence of the unfavorable weather, which, as already stated at the outset of this chapter, interfered materially with field progress in the northern part of the section, has not been met, and the basis of the hydrography is yet wanting. The impediments referred to being within the knowledge of Commander Alden, a visit was made to the harbor in the steamer Active, and such an examination conducted as could be made in advance of the close determination of points along the shores by the land party. In allusion to his reconnaissance Commander Alden says: "The result shows that the harbor has a bar over which can be carried from two and a half to three and a half fathoms of water. It was tolerably smooth during the flood, but when the ebb tide made the sea broke entirely across the entrance. The soundings made inside correspond very closely with those on the chart of the U. S. Exploring Expedition; and it would seem, as there is no bar laid down, that the survey just referred to was not carried quite out to it, or that there has been an important change since it was executed in 1841."

Hydrography of the Gulf of Georgia, W. T.—The following statistics represent the supplementary work executed for the northwest boundary commissioner by the hydrographic party under Commander Alden, in the steamer Active:

Miles run in sounding	105
Angles measured	366
Casts of the lead	967

Tidal observations.—One of the self-registering gauges in the general charge of Lieut. G. H. Elliot, U. S. Engineers, as stated under the head of Section X, has been kept in working order at Astoria, and the series from it continues to give satisfactory results.

OFFICE-WORK.

The Coast Survey Office in Washington city has, during the year, remained under the charge of *Captain W. R. Palmer, U. S. Topographical Engineers*, who has, as usual, administered it efficiently and acceptably. In the intervals of his absence, the duties devolving on him were discharged by *Lieutenant A. P. Hill, U. S. A.*, whose connection with the office and efficiency as general assistant have been referred to in my previous annual reports.

The report of Captain Palmer, given in Appendix No 17, and accompanied by detailed statements from the chiefs, of the several office divisions, show the occupation of the persons engaged in them within the year, and the scope and relation of the office as connected with the field-work of the survey. No change has been made in the allotment of the material received from the field, the past working of the divisions, as organized several years ago, having continued to meet the requirements of the survey and the calls incident thereto. In the order in which the office divisions have been heretofore named, summary notices are here appended of the employments in each.

Computing division.—Under the charge of *Assistant Charles A Schott*, this division has fully

sustained its efficiency. The distribution of work done is set forth in his report appended to that of the assistant in charge of the office (Appendix No. 17,) as are also those relating to the other office divisions.

In addition to his general duties, Mr. Schott has continued the discussion of the secular change in the magnetic declination, and has furnished another contribution (Appendix No. 17) to our knowledge on that interesting subject. The computations made in the division have been performed as follows:

Assistant T. W. Werner has been employed in reducing from the records of triangulations and latitude observations; *Mr. Eugene Nulty* on latitudes, azimuth, and time observations; *Mr. James Main* on azimuth, latitude and revisions, and on computations connected with the determination of the magnetic elements; *Mr. G. Rumpf* on triangulations and the computation of geographical positions, and also in reducing magnetic observations; *Mr. J. Wiessner* on triangulations, until his resignation on the 1st of April; *Mr. W. D. Storke* on reductions of triangulations, and in preparing the list of geographical positions which accompanies this report; *Mr. J. T. Hoover* in clerical and miscellaneous duties; and *R. Freeman* in making duplicates of field and office records.

Tidal Division.—The labors of this division, which have been, as heretofore, conducted by Assistant *L. F. Pourtales*, are stated in the Appendix before referred to, with the names of the persons employed.

Mr. Pourtales has continued incidentally the investigation of specimens of soundings, and has made developments of much interest in this branch of research.

The force in the division has been employed as follows: *Mr. R. S. Avery* on discussions relative to a generalization of results from the Boston tidal observations; *Mr. S. Walker* in verifying tidal records and corresponding with the observers; *Mr. J. Downes* in graphical decompositions, reductions, and comparisons; and *M. Thomas* and *S. D. Pendleton* have been employed in miscellaneous reductions.

Sub-Assistant C. Fendall and *Messrs. J. Gilliss, R. E. Evans, O. Hinrichs, P. H. Donegan*, and *A. W. King* served temporarily in this division during part of the year.

Drawing Division.—Until the end of June this division remained in charge of *Lieut. J. C. Tidball, U. S. A.*, and his effective supervision is referred to in the report of *Lieut. Thomas Wilson, U. S. A.*, under whose direction the duties have been carried on since that date. The distribution of work has been as follows: *Assistants W. M. C. Fairfax* and *M. J. McClery* on reductions of topography, the latter also in making additions to the Congress map; *Mr. A. Boschke* on projects; *Mr. A. Lindenkohl* on reductions, projections, and verification; *Mr. A. Balbach*, during part of the season, on hydrographic reductions, and now on general duty as draughtsman in the hydrographic division; *Mr. E. Hergesheimer* on verification and hydrographic reductions; *Mr. W. P. Schulz* on reductions of various kinds, progress sketches, projects, and projections; *Mr. L. D. Williams* on fine reductions and verification; *Mr. A. Strausz* on soundings for charts; *Mr. W. T. Martin* on topographical drawing; *Mr. P. Witzel* on projections and preliminary charts; *Mr. S. B. Linton* on lettering, and in making additions to the progress sketches; *Mr. F. Fairfax* on general topography and tracings; and *Mr. B. Hooe* and *Artificer J. A. Campbell* on tracings generally.

Engraving Division.—The duties of this division were conducted by Lieut. Rufus Saxton, U. S. A., until the 1st of April. Since that date the division has been temporarily in charge of Mr. Edward Wharton.

The allotment of work to the engravers regularly employed has differed but little from that of

last year. *Mr. G. McCoy* has been engaged on topography and views for charts; *Mr. F. Dankworth*, until within a short period before his death, on topography; *Mr. John Knight* on first-class lettering; *Messrs. A. Rolle, J. Enthoffer*, and *A. Sengteller*, on topography; *Mr. G. B. Metzeroth* on topography, views, and sanding for charts; *Messrs. A. Blondeau* and *W. Phillips* on topography; *Mr. H. S. Barnard* on sanding for charts; *Mr. J. C. Kondrup* on first-class outlines, letters, and figures; *Mr. H. C. Evans* on topography and sanding; *Mr. J. V. N. Throop* on letters and figures for harbor and preliminary charts; *Mr. A. Maedel* on topography and sanding for harbor and river charts; *Mr. A. Petersen* on letters and figures, as also *Messrs. E. A. Maedel, W. Langran*, and *W. Ogilvie; Mr. R. F. Bartle* on topography and sanding; and *Messrs. F. W. Benner, W. A. Thompson*, and *E. H. Sipe*, on progress and other sketches, and miscellaneous work.

ELECTROTYPE AND PHOTOGRAPH DIVISION.—The report of *Mr. George Mathiot*, subjoined to that of the assistant in charge, in Appendix No. 17, gives in detail a statement of the work done in the division within the year. In addition to his regular duties, Mr. Mathiot has made numerous trials, resulting at length in the successful application of the photographic process as a substitute for hand reductions for the engraver. I have already stated at more length the progress made in this important branch of the service in the introduction of this report. In all the labors of the division Mr. Mathiot was assisted by *Mr. David Hinkle*, whose application to its various duties are specially mentioned in the report already referred to.

MISCELLANEOUS DIVISION.—Under this head are classed the printing and distribution of maps and charts, and the distribution of the office complement of the annual reports. The report of *Lieut. J. R. Smead, U. S. A.*, who took charge on the detachment from the Coast Survey of *Lieut. J. P. Roy, U. S. A.*, in last June, shows that the activity required in this division has been fully kept up. Over fifteen thousand copies of various charts have been distributed during the year, and an aggregate of six thousand eight hundred and seventeen copies of the annual reports and accompanying sketches.

Lieut. Smead has been assisted by *Mr. V. E. King*, who also performs clerical duty in the office of the assistant in charge.

The printing has been performed, as heretofore, by *Mr. J. Rutherdale*, aided by *Mr. J. Barrett.*

Mr. F. Holden continued, until near the close of the present surveying year, on duty in the map room, and was employed in backing and preparing paper to be used as projections for plane-table and hydrographic sheets. This duty, since the 1st of September, has been performed by *Mr. W. Mertz.*

The space required for the constant additions to the archives of the survey is referred to by the assistant in charge as being yet unprovided for. Part of the inconvenience felt arises from the risk of transferring for deposit the original maps and charts to any but a thoroughly fire-proof building.

In the carpentry, the various calls and requirements incidental to the work of the survey have been met as usual. The labors of the shop, which have been conducted, as heretofore, by *Mr. A. Yeatman*, are stated in detail in the report of the assistant in charge of the office, as are also those of the instrument shop, in which the work is directed by *Mr. J. Vierbuchen.*

Captain Palmer specially commends the zeal and ability of his principal clerk, *A. W. Russell, esq.*

Assistant L. F. Pourtales, in charge of the tidal division, and *Professor W. P. Trowbridge*, whose duties connected with the preparation of a portion of the records for publication have been before alluded to, have rendered acceptable assistance in certain special discussions conducted under my immediate direction.

Commander S. S. Lee, U. S. N., took charge of the hydrographic division of the office on the 1st of September, and has discharged, also, the duties of hydrographic inspector, attending to the repairs and outfit of the vessels used by all the parties of the survey. The knowledge possessed by Commander Lee of construction and equipment has, under the general rules and arrangements adopted first at the suggestion of Lieutenant Maffitt, introduced an efficiency into this branch of the service which insures for the future decided economy. *Mr. A. Balbach* has assisted in the hydrographic division as clerk and draughtsman.

I have only to reiterate the expression of the opinion which I entertain of the great value of the services of *Samuel Hein, esq.*, general disbursing agent of the Coast Survey, and of those of the principal clerk in the Superintendent's office, *W. W. Cooper, esq.*

Respectfully submitted by

A. D. BACHE,
Superintendent United States Coast Survey.

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX.

APPENDIX No. 1.

Distribution of the parties of the Coast Survey upon the coast of the United States during the surveying season of 1858–'59.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION I.				
From Passamaquoddy bay to Point Judith, including the coast of Maine, New Hampshire, Massachusetts, and Rhode Island.	No. 1	Primary triangulation, astronomical and magnetic observations.	A. D. Bache, Superintendent; G. W. Dean, assistant; Edward Goodfellow, sub-assistant; R. E. Halter, aid; H. W. Bache, aid.	Howard and Cooper stations, Washington county, Me., occupied, and Chamcook, N. B., for extending the primary triangulation across the northeastern boundary. Geodetic observations completed at the three stations, with determinations of latitude, azimuth, and the magnetic elements at Howard and Cooper.
	2	....	C. O. Boutelle, assistant; C. H. Boyd, aid.	Reconnaissance and selection of stations for the secondary triangulation of Passamaquoddy bay, erection of signals for primary triangulation, and connection of the Epping base with adjacent stations. (See also Section V.)
	3	Secondary triangulation.	J. A. Sullivan, sub-assistant; R. M. Stiles, aid; J. D. Bradford, aid.	Stations occupied in the secondary triangulation of Penobscot bay, below the primary line "Ragged Mount—Isle au Haut," and signals erected for continuing work northward towards the head of the bay. (See also Section VI.)
	4	Secondary triangulation.	F. P. Webber, sub-assistant; J. Kincheloe, aid.	Triangulation continued from Damariscotta river, and over Muscongus bay and sound, connecting eastward with stations in the lower part of Penobscot bay. (See also Section V.)
	5	Topography	W. H. Dennis, sub assistant; J. L. Tilghman, aid.	Detailed survey of Wiscasset, Me., and its environs, and topography of the opposite shore of Wiscasset bay, including part of the Edgecombe quarries. (See also Section IX.)
	6	Topography.......	R. M. Bache, assistant; W. S. Edwards, sub-assistant.	Plane-table survey of Bath, Maine, and detailed topography continued on the shores of Kennebec river and Merrymeeting bay.
	7	Topography.......	A. W. Longfellow, assistant; A. S. Wadsworth, assistant; James Gilliss, aid.	Details of the shores of Casco bay, from and including the Presumpscot river, northward to Prince's Point, and survey of the interior on Cousin's, Long, Great Jebeig, Hope, Crotch, and Jewell's islands, east of Portland harbor.

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION I—(Continued.)	No. 8	Topography	C. Fendall, sub-assistant	Plane-table survey of the coast of Maine, from Prout's Neck, southward and westward, to Kennebunk river, including the shores of Saco bay, and detailed survey of the Isles of Shoals.
	9	Topography	A. M. Harrison, assistant; P. C. F West. sub-assistant; A. W. Thompson, aid.	Topography of Barnstable harbor completed, and the survey of Cape Cod peninsula in that vicinity extended from West Barnstable eastward to North Dennis, including Yarmouth, Barnstable, and Pond Village.
	10	Hydrography	Lieut. Comg. John Wilkinson, U. S. N., assistant.	In-shore hydrography extended from Cape Newagen and Damiscove island, southward and westward, to Cape Small, outside of Kennebec entrance, and soundings completed abreast of and between Portland Light and Green island, Casco bay. Rocks determined in position, and off-shore soundings carried from Cape Elizabeth southward to Nausett Centre Light, Cape Cod.
	11	Hydrography	Lieut. Comg. Alexander Murray, U. S. N., assistant; C. Fendall, sub-assistant.	Soundings completed in-shore from Cape Elizabeth. southward and westward, to Cape Porpoise, Me. Deep-sea line carried from Cape Ann, across Cashe's ledge, to Seal island, and thence by traverses, westward, across the coast of Maine to Cape Elizabeth. Re examination made in Salem and Boston harbors, Massachusetts. (See also Section IV.)
	12	Tidal observations	T. E. Ready	Record kept with self-registering tide-gauge at U. S. navy yard, Charlestown, Massachusetts.
	13	Magnetic observations.	Charles A. Schott, assistant; J. L. Tilghman, aid.	Determination of the magnetic declination, dip, and intensity at Portland, Me., and Portsmouth, N. H; at Newburyport and Ipswich, Mass; at Gloucester, Thompson (primary triangulation station,) Rockport, and Annis Squam, on Cape Ann. (See also Section II.)
SECTION II. From Point Judith to Cape Henlopen, including the coast of Connecticut, New York, and New Jersey, and the shores of Pennsylvania and Delaware.	No. 1	Triangulation	Edmund Blunt, assistant; Lieut. W. R. Terrill, U. S. A., assistant; G. H. Bagwell, sub-assistant; Rufus King, jr., aid.	Triangulation of Hudson river, from a station near Hudson northward to New Baltimore, and determination of numerous points in the vicinity of Yonkers, for plane-table purposes.
	2	Topography	H. L. Whiting, assistant; John Mechan, sub-assistant; N. S. Finney, sub-assistant.	Detailed topography completed on both sides of Hudson river, between Spuyten Duyvel creek and Hastings; and also north and south of Tarrytown, N. Y. including Yonkers, Upper and Lower Nyack, the Palisades, and Piermont.
	3	Topography	F. W. Dorr, sub-assistant; C. Rockwell, aid; McLane Tilton, aid.	Supplementary details of topography in the vicinity of South Jamaica, L. I., Morrisania, Brooklyn, Williamsburg, High Bridge, and Hudson City, for the plane-table survey of New York harbor. (See also Section VI.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION II—(Continued.)	No. 4	Hydrography	Lieut. Comg. T. A. Craven, U. S. N., assistant.	Re-examination and development of changes in the vicinity of the Battery Shoal, New York harbor. (See also Section VI.)
	5	Tides and currents	H. Mitchell, assistant; W. T. Bright, aid.	Development of the sub-currents traversing the waters of New York harbor.
	6	Tidal observations	R. T. Bassett	Series kept with self-registering tide-gauge at Governor's island, (New York harbor,) and with the box-gauge at Brooklyn, L. I.
	7	Magnetic observations.	Charles A. Schott, assistant; J. L. Tilghman, aid.	Determination of the magnetic declination, dip, and intensity, at Hartford, Conn.; Springfield, Chesterfield, and Deerfield, Mass.; and Rutland, Vt. (See also Section I.)
SECTION III.				
From Cape Henlopen to Cape Henry, including the coast of part of Delaware, and the coast of Maryland and part of Virginia.	No. 1	Triangulation	John Farley, assistant	Reconnaissance made and signals erected for extending work on the Potomac river from Piney Point upwards, to include Britton's bay; triangulation of Hampton Roads completed and connected with the main series on Chesapeake bay, and base measured near Claremont, Va., for verifying the triangulation of James river.
	2	Triangulation and topography.	Charles Ferguson, sub-assistant.	Survey of the main shore and islands in Chincoteague bay, Md. and Va., completed, and points determined for extending the topography northward into Sinepuxent bay. (See also Section VI.)
	3	Topography	I. Hull Adams, assistant	Shore-line of the Patuxent river, Md., traced from Holland's Point upwards to Hall's creek, nearly completing the preliminary survey. Shores of the St. Mary's river, Md., traced from its entrance northward to Warehouse Point, including the adjacent parts of St. Inigo's and Carthagena creeks.
	4	Topography	John Seib, assistant	Topography of Milford Haven, and Horn and Winter harbors, on the western shore of Chesapeake bay, completed. (See also Section V.)
	5	Topography	I. Hull Adams, assistant	Shore-line traced between Westover and Little Brandon, completing the preliminary survey of James river, Va.
	6	Hydrography	Commander W. T. Muse, U. S. N., assistant.	Hydrography of the Patuxent river, Md., extended from Holland's Point upwards to Hall's creek, and that of the St. Mary's river, Md., from its entrance to Comb's wharf; soundings made between Coggin's Point and Little Brandon, completing the hydrography of James river, Va., and supplementary work done in Big and Little Annemessex rivers to complete the hydrography of Tangier sound.
	7	Tidal observations	M. C. King	Self-registering gauge kept in operation at Old Point Comfort, Va. Series continued with the self-registering tide-gauge at the U S. navy yard, Washington, D. C.

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION IV.				
From Cape Henry to Cape Fear, including part of the coast of Virginia and N. Carolina.	No. 1	Primary triangulation.	Captain T. J. Cram, U. S. Topographical Engineers, assistant.	Reconnaissance and erection of signals at primary stations for the triangulation of Pamplico sound, N. C, and its connection with the base on Bodies island.
	2	Triangulation	A. S. Wadsworth, assistant...	Remeasurement of triangulation in the vicinity of Federal Point, (Cape Fear entrance,) and connection with a base of verification on Smith's island, with a station at Smithville, and with Fort Caswell, N. C. (See also Section I.)
	3	Topography.......	John Mechan, sub-assistant; F. R. Hassler, aid	Topographical survey completed from Lynn Haven bay and Cape Henry southward into Currituck sound, N. C., including Broad bay, North bay, Back bay, Knott's island, and intermediate details. (See also Section II)
	4	Hydrography	Lieut. Comg. Alexander Murray, U. S. N., assistant.	In-shore hydrography extended from Bogue inlet southward and westward to New River inlet, coast of North Carolina; and lines of soundings run between Cape Henry and Cape Hatteras. (See also Section I and Gulf Stream.)
SECTION V.				
From Cape Fear to St. Mary's river, including the coast of South Carolina and Georgia.	No. 1	Astronomical and magnetic observations.	A. D. Bache, Superintendent; G. W. Dean, assistant; Edward Goodfellow, sub-assistant; McLane Tilton, aid; W. H. Odenheimer, aid.	Determination of latitude and azimuth at Smithville, N. C., with observations for local time, and the magnetic elements. (See also Section I.)
	2	Triangulation and topography.	C. P. Bolles, assistant; O. Hinrichs, aid.	Triangulation extended from Shallotte inlet westward to Little river, N. C, and shore line survey contined from Tubb's inlet westward to the southern boundary of North Carolina.
	3	Astronomical and magnetic observations, and secondary triangulation.	C. O. Boutelle, assistant; Lieutenat Thomas Wilson, U. S A., assistant; W. S. Edwards, sub-assistant; C. H. Boyd, aid.	O servations for latitude, azimuth, and local time at Port Royal station, S. C.; magnetic elements determined at the same station. Tripods erected, and lines traced for primary triangles south and west of the Edisto base. Secondary triangulation of Beaufort, Chechessee, and Colleton rivers, S. C. (See also Section I.)
		Secondary and tertiary triangulation.	F. P Webber, sub-assistant; J. Kincheloe, aid.	Secondary triangulation from the Sapelo preliminary base southward, across Doboy and Altamaha sounds, Georgia. Tertiary triangulation of Sapelo island, and of the "Inland Passage" between Altamaha and St Simon's entrance. (See also Section I)
	5	Topography.......	John Seib, assistant; C. Rockwell, aid.	Shore-line survey from St. Helena sound to Savannah river, Ga., including the Hunting islands, Eding's island, the shores of Port Royal sound, with the entrances of Beaufort, Broad, Chechessee, and Colleton rivers, Foot Point, Hilton Head island, May river, and the shores of Calibogue sound. (See also Section III.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION V—(Continued.)	No. 6	Topography	H. S. Du Val, sub-assistant; J. D. Bradford, aid.	Topography of St. Catharine's sound, Ga., and of Bear river, connecting it with Ossabaw, and including the entrances of the Medway and North Newport rivers, and the outer shores of Ossabaw and St. Catharine's islands, adjacent to the entrance of the sound.
	7	Hydrography	Lieut. Comg. J. P. Bankhead, U. S. N., assistant.	In-shore soundings completed from Cape Fear entrance southward and westward to Tubb's inlet, N. C.; and off shore hydrography extended between Cape Fear and Charleston harbor, with observations on the ocean current southward of Cape Fear. Hydrography of Bull's bay, S. C., completed, and the inland passage from it sounded southward to Caper's island.
	8	Hydrography	Lieut. Comg. C. M. Fauntleroy, U. S. N., assistant.	Resurvey of the channels leading into Port Royal sound, S. C., including Joiner's bank, off Hilton Head island, and the hydrography of the Chechessee and Colleton rivers, abreast of Foot Point. Soundings completed in the approaches and on the bar of Sapelo sound, Ga. (See also Section II.)
	9	Tidal observations.	W. R. Herron	Series continued at the custom-house wharf, Charleston, S. C., with the self-registering tide-gauge.
	10	Inspection	A. D. Bache, superintendent.	
GULF STREAM		Hydrography	Lieut. Comg. T. A. Craven, U. S. N., assistant; Lieut. Comg. Alexander Murray, U. S. N., assistant; Lieut. Comg. T. B. Huger, U. S. N., assistant.	Soundings made for depth and temperature across the stream from Carysfort light-house and Sombrero key, and the line verified between Tortugas and Havana. Deep-sea soundings made in the axis of the stream between Cape Lookout and Cape Hatteras. (See also Sections I, V, VII, and VIII.)
SECTION VI.				
From St. Mary's river to St. Joseph's bay, including the eastern and part of the western coast of Florida peninsula, with the Florida reefs and keys.	1	Triangulation	Captain M. L. Smith, U. S. Topographical Engineers, assistant; J. S. Bradford, aid; W. H. Gardner, aid; J. C. Young, aid, (part of season.)	Air-line triangulation between Fernandina and Cedar Keys extended from Padgett's Station southward and westward to Waldo, and plane-table survey of the tract of country included.
	2	Triangulation	Benjamin Huger, jr., sub-assistant; Rufus King, jr., aid.	Preliminary base measured near St. Augustine, Florida, and triangulation extended twenty miles northward along the coast, embracing also North river; signals erected for continuing the work southward.
	3	Triangulation	J. A. Sullivan, sub-assistant; R. M. Stiles, aid.	Measurement of a preliminary base at Indian River inlet, Florida, and erection of signals for triangulation north and south of Fort Capron. (See also Section I.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION VI—(Continued.)	4	Triangulation	Lieut. A. H. Seward, U. S. A., assistant; Lieut. W. Myers, U. S. A., assistant.	Triangulation extended eastward along the inner line of the Florida keys, from Lignum Vitæ to Pigeon key.
	5	Triangulation	Lieut. W. R. Terrill, U. S. A., assistant; C. Fendall, sub-assistant; C. B. Baker aid.	Extension of work in Charlotte harbor, Florida, from Captiva Pass northward to Punta Gorda.(See also Section II.)
	6	Topography	C. T. Iardella, sub-assistant; F. F. Nes, aid.	Western shores of Key Biscayne bay and Card's sound, Florida, traced from Shoal point southward to Clay point. Topography completed on the western side of Key Largo, and numerous patches on the Florida reef surveyed, between Lignum Vitæ and Oyster key.
	7	Topography......	F. W. Dorr, sub-assistant; Charles Ferguson, sub-assistant.	Plane-table survey of Charlotte harbor, Florida, continued, embracing the western side of Pine island, the upper part of Sanibel island, and Captiva and La Costa islands, extending the work northward to Boca Grande. (See also Sections II and III.)
	8	Hydrography......	Lieut. Comg. T. A. Craven, U. S. N., assistant.	Reconnaissance line from Cape Cañaveral to St. Lucie inlet—Soundings on the outside of Florida reef continued from Eagle cove eastward to Coffin's Patches. (See also Section II and Gulf Stream.)
	9	Tidal observations.	G. Würdemann	Series continued with self-registering guages at Fort Clinch, Tortugas, Charlotte harbor, and Egmont key, (Tampa.)
	10	Inspection	A. D. Bache, superintendent	
SECTION VII. From St. Joseph's bay to Mobile bay, including the coast of western Florida and the coast of Alabama.	1	Triangulation	G. H. Bagwell, sub-assistant; M. O. Hering, aid.	Triangulation on the western side of the Florida peninsula continued from Crystal reef southward, to include the entrance of Chassahowitzka river. (See also Section II.)
	2	Triangulation	Spencer C. McCorkle, sub-assistant; A. W. Thompson, aid.	Connection made by triangulation between St. George's sound and St. Mark's harbor, Fla., and reconnaissance for extending work eastward to include Ocilla river.
	3	Triangulation	F. H. Gerdes, assistant; G. U. Mayo, aid.	Triangulation carried eastward into Santa Rosa sound, beyond Little Sabine bayou, from finished limits in Pensacola bay, Fla. (See also Section VIII.)
	4	Topography.......	N. S. Finney, sub-assistant; J. L. Tilghman, aid.	Plane-table survey of the keys and shore-line abreast of Crystal reef, Fla., extended southward to Homosassa river, and from Chassahowitzka river southward to Raccoon Point. (See also Section II.)
	5	Topography.......	G. D. Wise, assistant; C. W. Duval, aid.	Topography of St. James's island, Fla., nearly completed, with the opposite shore of Ocklokonee bay, and part of the shores of Dickerson's bay in the direction of St. Mark's.

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION VII—(Continued.)	6	Topography	F. H. Gerdes, assistant; G. U. Mayo, aid.	Plane-table survey within the season's triangulation, including Santa Rosa island east and west of Little Sabine bayou, and part of the Live Oak plantation on the opposite shore of Santa Rosa sound. (See also Section VIII.)
	7	Hydrography	Lieut. Comg. T. B. Huger, U. S. N., assistant.	Re-examination of the channels leading into the harbor at Cedar Keys, Fla. (See also Section VIII.)
	8	Hydrography	Lieut. Comg. J. K. Duer, U. S. N., assistant.	Hydrography of the eastern entrance to St. George's sound, Fla., including the new channel passing Dog island. Additional soundings made inside and abreast of the West Pass. (See also Section IX.)
	9	Tidal observations		Series continued with self-registering tide-gauge at Cedar Keys, and observations recorded by a self-registering gauge at the U. S. navy yard, Warrington, Fla.
SECTION VIII.				
From Mobile bay to Vermilion bay, including the coast of Alabama and Mississippi, and part of the coast of Louisiana.	No. 1	Triangulation and topography.	Stephen Harris, sub-assistant; R. E. Halter, aid; H. W. Bache, aid.	Triangulation from Sand Fly station southward and westward along the shores of Isle au Breton sound to Point Fortuna, La., and shore-line of keys traced within the same limits.
	2	Triangulation and topography.	F. H. Gerdes, assistant; G. U. Mayo, aid.	Tertiary triangulation of Pass à Loutre and Southeast Pass of the Mississippi river, and of the shores of Bay Rondo. Plane-table survey of the north side of the Mississippi delta, from the head of the passes to the Belize. (See also Section VII.)
	3	Topography	W. S. Gilbert, sub-assistant; R. E. Evans, aid, (part of season.)	Detailed survey between Lake Borgne and Lake Pontchartrain continued southward and westward from Chef Menteur to Little river, and extended on the north side of Lake Pontchartrain to Bayou Bonfouca. Shore-line survey carried on the same side to Ragged Point, and on the southern side to the Jefferson railroad.
	4	Triangulation and topography.	F. H. Gerdes, assistant; J. G. Oltmanns, sub-assistant.	Triangulation and topography of the shores of Côte Blanche bay, La., extended westward from Malony's Point to Côte Blanche island, and including the northeastern part of Marsh island. (See also Section VII.)
	5	Hydrography	Lieut. Comg. T. B. Huger, U. S. N., assistant.	Reconnaissance of Pass à Loutre, Mississippi delta, from the bar upwards, with tidal observations. Hydrography completed in Atchafalaya bay, and soundings extended westward to East Point (Marsh island) and Point Malone, including Côte Blanche bay east. (See also Gulf Stream and Section VII.)
	6	Hydrography	W. S. Gilbert, sub-assistant.	Sounding out the Rigolet passage, from Lake Borgne to Lake Pontchartrain, La.

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION IX.				
From Vermilion bay to the southwestern boundary at the Rio Grande, including part of the coast of Louisiana and the coast of Texas.	No. 1	Triangulation	S. A. Gilbert, assistant; Charles Hosmer, aid.	Extension of triangulation from Matagorda entrance southward and westward over Espiritu Santo, San Antonio and Aransas, and Copano bays, with their dependencies.
	2	Topography........	W. H. Dennis, sub-assistant; T. C. Bowie, aid.	Plane-table survey completed, including the shores of Espiritu Santo and San Antonio bays, with the middle part of Matagorda island, Texas. (See also Section I.)
	3	Hydrography	Lieut. Comg. J. K. Duer, U. S. N., assistant.	Soundings in Matagorda bay completed between the peninsula and the main, and extending from Matagorda City southward and westward to Palacios Point (See also Section VII)
SECTION X.				
Western coast of the United States, from San Diego to the 42d parallel, including the coast of California.	No. 1	Triangulation......	W. E. Greenwell, assistant ..	Revision of primary work connecting with the San Pedro base, Cal; and triangulation of the northern part of Santa Rosa island, Santa Barbara channel.
	2	Triangulation and topography.	W. M. Johnson, sub-assistant; C. M. Bache, sub-assistant.	Triangulation and topography of San Pedro harbor, Cal.; and plane-table survey continued on Santa Cruz island, Santa Barbara channel.
	3	Triangulation and astronomical observations.	George Davidson, assistant; E. H. Fauntleroy, aid; A. T. Mosman, aid, (part of season)	Primary triangulation from San Francisco entrance extended northward to Sulphur Peak, with latitude and azimuth determinations. Secondary and tertiary work executed over Drake's bay and Point Reyes, and connected with primary stations. Positions of the Farallones determined by the triangulation.
	4	Triangulation and topography.	James S. Lawson, sub-assistant; Alexander Agassiz, aid.	Triangulation and topography of Crescent City harbor, Cal. (See also Section XI.)
	5	Hydrography.....	Commander James Alden, U. S. N., assistant.	Hydrography completed of the anchorage and vicinity of San Pedro, Cal. Soundings made in the approaches to the Golden Gate Resurvey of Humboldt harbor, and hydrography of Crescent City harbor, Cal., completed. (See also Section XI.)
	6	Tidal observations .	Lieut. G. H. Elliot, U. S. Engineers	Series continued with self-registering tide gauges at San Diego and San Francisco. (See also Section XI.)
SECTION XI.				
Western coast of the United States, from the 42d parallel to the northern boundary, including the coast of Oregon and Washington Territories.	No. 1	Triangulation and topography.	James S. Lawson, sub-assistant; Alexander Agassiz, aid.	Stations occupied on Point Roberts, and triangulation extended westward to include the forty-ninth parallel, and the lower part of Galiano island. (See also Section X.)

APPENDIX No. 1—Continued.

Limits of sections.	Parties.	Operations.	Persons conducting operations.	Localities of operations.
SECTION XI—(Continued.)	No. 2	Hydrography	Commander James Alden, U. S. N., assistant.	Hydrographic reconnaissance of the entrance to Coquille river, Oregon, and of Gray's harbor, W. T. (See also Section XI.)
	3	Tidal observations	Lieut. G. H. Elliot, U. S. Engineers.	Observations continued with self-registering gauge at Astoria, Oregon. (See also Section X.)

APPENDIX No. 2.

List of Army officers on Coast Survey duty March 1, 1859.

Officers.	Rank.	Date of attachment.
Thomas J. Cram	Captain topographical engineers	March 26, 1858
W. R. Palmer	Captain topographical engineers	November 17, 1857
Martin L. Smith	Captain topographical engineers	December 9, 1856
Augustus H. Seward	Captain 5th infantry	December 11, 1851
Ambrose P. Hill	First lieutenant 1st artillery	November 23, 1855
J. C. Tidball	First lieutenant 2d artillery	September 6, 1854
Edward B. Hunt	First lieutenant engineers	May 5, 1851
Rufus Saxton	First lieutenant 4th artillery	December 25, 1855
James P. Roy	First lieutenant 2d infantry	October 7, 1853
William R. Terrill	First lieutenant 4th artillery	March 19, 1858
Thomas Wilson	First lieutenant 5th infantry	May 26, 1857
William Myers	First lieutenant 9th infantry	September 10, 1857

APPENDIX No. 3.

List of Army officers on Coast Survey duty September 1, 1859.

Officers.	Rank.	Date of attachment.
Thomas J. Cram	Captain topographical engineers	March 26, 1858
W. R. Palmer	Captain topographical engineers	November 17, 1857
Martin L. Smith	Captain topographical engineers	December 9, 1856
Edward B. Hunt	Captain engineers	May 5, 1851
Ambrose P. Hill	First lieutenant 1st artillery	November 23, 1855
R. G. Cole	First lieutenant 8th infantry	June 11, 1859
W. R. Terrill	First lieutenant 4th artillery	March 19, 1858
J. R. Smead	First lieutenant 2d artillery	May 21, 1859
Thomas Wilson	First lieutenant 5th infantry	May 26, 1857

APPENDIX NO. 4.

List of Navy officers on Coast Survey duty March 1, 1859.

Vessel.	Locality of service.	Officers.	Rank.	Date of attachment.
	Office-work	W. T. Muse	Commander	February 27, 1857
	Do	J. N. Maffitt	Lieutenant	November 1, 1858
	Do	W. G. Temple	do	June 5, 1855
Steamer Bibb	Section IV	Alexander Murray	Lieutenant commanding	April 23, 1858
Schooner Crawford	Section V	J. P. Bankhead	do	October 16, 1858
Schooner Varina and tender Fire Fly.	Section V	C. M. Fauntleroy	do	November 13, 1858
Steamer Corwin	Section VI	T. A. Craven	do	October 25, 1858
Steamer Vixen	Sections VII and IX	John K. Duer	do	August 1, 1855
Steamer Walker	Section VIII	Thomas B. Huger	do	October 12, 1857
Steamer Active	Sections X and XI	James Alden	Commander	May 18, 1849
		Wash'ton Gwathmey	Lieutenant	May 20, 1858
		P. C. Johnson	do	July 20, 1854
		J. G. Mitchell	do	June 14, 1858
		James Suddards	Passed assistant surgeon	July 1, 1857
		N. C. Davis	First assistant engineer	February 22, 1853

APPENDIX No. 5.

List of Navy officers on Coast Survey duty September 1, 1859.

Vessel.	Locality of service.	Officers.	Rank.	Date of attachment.
	Office-work	S. S. Lee	Commander	August 8, 1859
Steamer Bibb	Section I	Alexander Murray	Lieutenant commanding	April 23, 1858
Steamer Corwin	Section I	John Wilkinson	do	June 25, 1858
Steamer Walker	Section II	Thomas B. Huger	do	October 12, 1857
Steamer Vixen	Section II	Thomas S. Phelps	do	August 23, 1859
Schooner Varina	Section II	C. M. Fauntleroy	do	November 13, 1858
		F. B. Blake	Midshipman	August 16, 1859
Steamer Hetzel	Section III	W. T. Muse	Commander	February 27, 1857
Schooner Crawford	Section V	J. P. Bankhead	Lieutenant commanding	October 16, 1858
Steamer Active	Sections X and XI	James Alden	Commander	May 18, 1849
		Wash'n Gwathmey	Lieutenant	May 20, 1858
		J. G. Mitchell	do	June 14, 1858
		James Suddards	Passed assistant surgeon	July 1, 1857

APPENDIX No. 6.

List of information furnished by the Coast Survey during the year 1858–'59, under authority of the Treasury Department.

Date.		To whom communicated.	Information communicated.
1858.			
Nov.	13	Capt. H. W. Benham, Corps of Engineers	Tracing of Old Orchard shoal, Sandy Hook, and northern part of New York bay.
	13	........do	Tracing from reduction, scale $\frac{1}{20000}$, north and east of Sandy Hook, New York bay.
	24	Hon. A. G. Brown	Tracing of hydrography of Mississippi sound, north of Cat and Ship islands.
	29	Major H. C. Wayne	Tracing of topography of Long Island, from Islip to Babylon, N. Y.
Dec.	4	E. S. Sewall, esq	Tracing of topography of Pocomoke sound, Md.
	4	........do	Tracing of topography of Tangier sound, Md.
	7	Dr. J. M. Cuyler, U. S. A	Tracing of Hampton roads, Va.
	8	Hon. G. S. Hawkins	Tracing of East and West passes, St. George's sound, Fla.
	13	Hon. W. F. Russell	Tracing of topography of Esopus creek, N. Y.
	14	G. W. Blunt, esq	Tracing of coast of Massachusetts, from Nahant head to Ram island.
	14	J. R. Butts, esq	Tracing of East and West passes, St George's sound, Fla.
	14	G. W. Blunt, esq	Tracing of the "Triangles" and Boon island ledge, Salem harbor, Mass.
	17	E. T. Gray, esq	Tracing of reconnaissance of coast of Texas, from Matagorda bay to Aransas pass.
	20	Hon. W. F. Russell	Tracing of hydrography of Rondout creek, N. Y.
	20	Capt. J. D. Kurtz, Corps of Engineers	Shore-line of Kennebec river, Me.
	20	........do	Shore-line of Sheepscot river, Me.
	27	Hon. Guy M. Bryan	Tracing of Brazos river entrance, Texas.
	29	Alexander Brown, esq	Tracing showing wharves of Charleston city, S. C.
1859.			
Jan.	5	Prof. L. Agassiz	Tracing showing Sombrero and Delta shoals, Florida reefs.
	21	G. W. Blunt, esq	Tracing of hydrography of coast of Maine, from Kennebunkport to Isle of Shoals.
	21	E. L. Meyer, esq	Description of Coast Survey stations used in the triangulation in vicinity of Newark bay, N. J.
	21	G. W. Blunt, esq	Tracing of deep-sea soundings, Gulf of Mexico, from Delta of the Mississippi to Havana.
	29	Moses Bates, esq	Tracing of topography of Plymouth harbor and vicinity, Mass.
Feb.	18	James H. North, esq	Tracing of topography of Currituck sound, from Rattlesnake island to Currituck Court-House, N. C.
March	12	Mr. Winning	Geographical positions of certain Coast Survey stations in New York city.
	14	J. C. Brevoort, esq	Tracing of topography of Long island, from Brooklyn to Jamaica bay, N. Y.
	15	Light-house Board	Tracing of entrance to Matagorda bay, showing changes at Pass Cavallo, Texas
	15	J. W. Adams, esq	Results of current observations taken in East river, N. Y.
April	4	Com. W. H. Hutchings, U. S. mail steamship Galveston.	Tracing of hydrographic reconnaissance, from St. Mark's to St. Joseph's bay, Fla.
	4	John Kendall, esq	Tracing showing soundings recently made at the Rigolets, La.
	6	Prof. J. D. Dana	Tracing of off-shore chart, from Point Judith, R. I., to Cape Henlopen, Del.
	7	Capt. H. W. Benham, corps of engineers	Results of tidal observations at Sandy Hook, N. J., in 1858.
	7	..........do	Distances from Sandy Hook light-house to East and West beacons, New York bay.
	7	G. M. Hopkins, jr., esq	Tracings of topography of coast of New Jersey, south of Manasquam river.
	25	Hon. W. H. Seward	Chart of Hudson river, between Troy and Haverstraw, N. Y.
May	20	Editor of Indianola Courier	Distances between points in vicinity of Indianola, Texas.
	28	G. K. Walker, esq	Information relative to terminal point for a railroad on Apalachicola bay, Fla.
	31	A. Lindenkohl, esq	Tracing of topography of New York harbor.
June	10	Messrs. Allen & Co	Tracing of Foot Point, Daw island, and vicinity, near Port Royal sound, S. C.
	30	M. Parks, esq., President A. & O. Canal Co	Tracing of topography of Currituck sound, N. C

APPENDIX No. 6—Continued.

Date.		To whom communicated.	Information communicated.
1859.			
July	18	Washington Irving, esq	Tracing of topography of Hudson river, near Irving village, N.Y.
	29	Hon S. R. Mallory	Tracing of Pensacola city and vicinity, Fla.
	30	Lieut. Col. J. D. Graham, topographical eng'rs.	Tracing of Pensacola city and vicinity, Fla.
August	2	Messrs. Lowell & Senter	Tracing of Bang's island, Portland harbor, Me.
	11	Alexander Major, esq	Tracing of hydrography of Boston harbor from Egg rock to Grover's cliff, Mass.
	12	S. J. Martinet, esq	Tracing of Chester river, Md.
	13	Simeon Stevens, esq	Tracing of hydrography of Sheepscot river from Wiscasset to Hendrick Head light, Me.
	31	Lieut. Con. R. E. DeRussey, corps of engineers.	Tracing of coast of Rhode Island from Beaver Tail light to East rock.

APPENDIX No. 7.

Statistics of field and office-work of the United States Coast Survey during the years—

	Previous to 1844.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	Total.
Reconnaissance—																	
Area, in square miles	9,642	1,140	3,739	1,830	2,950	3,940	10,159	3,280	3,510	1,706	1,708	795	1,487	4,072	2,855	709	53,522
Parties, number of, in each year	4	2	4	5	5	7	6	4	6	6	5	13	7	5	8	4	....
Base lines—																	
Primary, number of	1	2	....	....	1	1	....	1	....	....	1	....	2	....	1	....	10
Secondary, number of	2	....	....	....	2	1	4	3	3	4	5	2	8	8	1	4	47
Length of, in miles	19½	16	....	....	9¼	13	6¼	17½	2	4½	18½	3¾	24½	9½	9	3½	156¾
Triangulation—																	
Area, in square miles	9,076	795	2,166	1,185	1,903	2,592	4,091	2,097	2,465	1,703	3,089	2,701	2,729	2,793	1,640	3,033	44,058
Extent of general coast, in miles	570	179	162	123	159	115	285	216	243	220	94	246	188	390	357	278	3,755
Extent of shore-line, in miles, including bays, sounds, islands, and rivers	1,588	589	554	1,018	541	796	1,328	730	1,097	1,104	884	1,269	1,401	1,895	1,481	1,715	17,990
Horizontal angle stations occupied	750	120	80	197	120	98	204	157	184	223	224	204	410	544	385	384	4,284
Geographical positions determined	1,183	147	148	372	191	227	319	294	307	446	346	388	584	1,240	777	603	7,575
Vertical angle stations occupied	15	2	5		3	1	18	13	22	14	7	89	6	1	4	11	218
Elevations determined, number of	44	12	7	46	44	1	59	22	53	66	9	127	6	12	15	14	537
Parties, number of, in each year	4	5	8	7	8	10	13	14	14	13	18	17	17	20	20	19	....
Astronomical operations—																	
Stations occupied for azimuth	9	8	2	2	3	3	4	4	6	6	9	5	4	2	1	2	70
Stations occupied for latitude	9	8	5		8	2	4	6	8	17	20	6	4	6	3	5	114
Stations occupied for longitude	1	1	....	2	3	3	7	3	7	18	21	4	1	1	2	2	76
Permanent longitude stations	....	1	1	2	1	1	2	3	5	5	5	4	3	1	1	1	....
Special longitude stations for occultations, &c	....	....	....	....	....	....	....	....	....	....	....	....	....	....	23	30	....
Parties, number of, in each year	1	3	2	2	3	3	5	5	6	4	7	7	6	4	3	4	....
Magnetic stations occupied, number of	....	14	21	28	19	4	11	9	10	8	13	9	8	23	4	5	186
Parties, number of, in each year	....	2	3	3	3	3	5	4	3	2	3	6	3	4	3	3	....
Topography—																	
Area surveyed, square miles	6,131	195	503	750	595	471	532	652	681	653	554	513	656	536	1,003	719	15,144
Length of general coast, in miles	414	110	168	119	117	185	95	133	260	236	251	174	176	165	309	172	3,084
Length of shore line, in miles, including rivers, creeks, and ponds	7,667	424	879	1,190	1,460	1,703	1,709	1,557	1,760	1,737	2,100	1,796	2,138	2,398	3,913	3,362	35,723
Length of roads, in miles	11,734	395	997	1,402	1,354	640	504	511	500	732	502	618	733	750	1,404	924	23,700
Parties, number of, in each year	6	5	6	8	9	9	11	11	13	13	17	12	17	17	23	23	....
Hydrography—																	
Parties, number of, in each year	2	5	5	6	6	8	11	11	12	9	9	10	11	12	12	10	....
Number of miles run while sounding	29,214	1,857	3,493	3,559	3,138	8,047	4,299	5,995	10,590	9,534	9,050	9,141	13,115	15,305	12,377	8,582	147,296
Area sounded out, square miles	9,601	663	677	574	979	2,185	1,335	2,012	3,200	2,823	2,061	1,937	3,433	3,743	2,705	1,674	39,572
Miles run additional, of outside or deep-sea soundings	1,800	1,020	....	....	210	2,240	....	1,198	2,037	360	1,902	2,793	5,219	1,202	3,218	2,092	25,291

APPENDIX No. 7—Continued.

	Previous to 1844.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	Total.
Hydrography—																	
Soundings, number of	808,147	120,827	125,173	220,402	228,402	255,003	265,824	264,718	371,660	288,375	305,377	162,454	526,875	439,614	506,034	513,607	5,402,492
Soundings in Gulf Stream for temperature	....	....	118	581	207	425	....	....	....	....	1,053	257	310	....	478	172	3,601
Tidal stations, permanent	....	2	2	2	3	3	3	3	4	4	7	7	7	8	8	8	....
Tidal stations occupied temporarily	127	14	33	39	33	29	35	41	51	76	78	89	80	77	74	35	911
Tidal parties, number of, in each year	2	5	5	5	5	8	11	11	12	9	11	12	13	14	14	11	....
Current stations occupied	....	27	42	41	59	54	28	44	41	24	89	10	84	84	156	47	830
Current parties, number of, in each year	....	3	5	3	3	4	6	4	7	7	5	3	5	6	6	2	....
Specimens of bottom, number of	1,029	2,776	89	129	371	769	287	381	278	215	141	135	255	146	422	236	7,659
Records—																	
Triangulation, originals, number of vols.	97	12	17	23	17	32	38	40	33	33	64	46	79	96	76	96	799
Astronomical observations, originals, number of volumes	17	10	11	10	16	22	72	30	41	48	29	88	35	12	35	63	539
Magnetical observations, originals, number of volumes	4	2	1	6	7	4	3	5	5	7	6	4	33	13	4	10	114
Duplicates of the above, number of vols	27	26	32	32	44	49	19	23	45	73	76	84	139	101	140	168	1,078
Computations, number of volumes	78	25	17	21	26	23	57	24	40	72	101	91	109	99	83	101	967
Hydrographic soundings and angles, originals, volumes	188	22	26	152	54	154	134	170	213	206	183	66	332	197	319	322	2,738
Hydrographic soundings and angles, duplicates, volumes	28	2	5	4	11	11	12	12	16	27	15	7	26	27	21	20	244
Tidal and current observations, originals, volumes	127	23	47	51	44	40	67	88	114	139	123	70	196	110	213	104	1,556
Tidal and current observations, duplicates, volumes	....	23	47	51	44	41	63	79	385	132	114	79	87	100	67	74	1,386
Sheets from self-registering tide-gauges, number of	....	....	....	....	....	....	....	....	....	26	72	106	80	103	119	141	647
Tidal reductions, number of volumes	....	46	94	102	88	80	16	58	22	26	17	99	79	73	63	64	927
Total number of volumes of records	566	191	297	452	351	456	481	529	914	763	728	634	1,115	828	1,021	1,022	10,348
Maps and charts—																	
Topographical maps, originals	168	14	16	25	29	20	22	30	41	47	54	45	55	51	74	44	735
Hydrographic charts, originals	142	9	8	18	18	21	16	20	47	56	56	52	65	62	51	31	672
Reductions from original sheets, number of	15	9	15	16	17	13	18	22	26	48	35	27	36	39	40	35	411
Total number of manuscript maps and charts	325	32	39	59	64	54	56	72	114	151	145	124	156	152	165	110	1,818
Number of sketches made in field and office	311	24	33	32	29	48	82	85	126	137	103	101	132	125	132	127	1,627
Engraving and printing—																	
Engraved plates of finished charts, number of	5	2	3	5	3	6	3	5	6	5	4	2	7	3	7	6	72

APPENDIX No. 7—Continued.

	Previous to 1844.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.	1858.	Total.
Engraving and printing—																	
Engraved plates of preliminary charts, sketches, and diagrams for Coast Survey reports, number of	....	....	....	4	5	7	6	10	38	20	39	42	46	51	51	25	344
Electrotype plates made in each year	....	....	....	....	1	7	6	25	16	23	47	77	50	69	79	95	495
Finished charts published in each year	....	4	3	4	3	10	3	4	6	6	3	2	8	3	5	6	70
Preliminary charts and hydrographic sketches published	....	....	....	2	4	2	4	10	36	19	34	34	34	38	41	22	280
Printed sheets of maps and charts distributed	....	169	416	1,708	1,104	2,923	1,848	326	5,649	5,799	8,042	5,195	5,392	8,858	19,147	4,209	70,785
Printed sheets of ditto deposited with sale agents	....	....	880	1,686	4,981	5,016	1,506	3,115	5,168	6,866	4,375	3,232	2,577	2,898	648	1,717	44,665
Library—																	
Number of volumes	....	....	....	....	....	655	95	590	333	171	273	155	250	389	106	116	3,133
Instruments—																	
Cost of	....	....	....	....	....	....	$6,326	$4,652	$4,603	$3,835	$5,296	$5,402	$3,958	$5,369	$3,185	$1,224	....

GENERAL NOTE.

Parties.—An average number is given for the years previous to 1844. A party operating in more than one section during the year is counted but once.

Triangulation.—The extent of general coast is measured in general outline, including Delaware and Chesapeake, as well as all open bays; but omitting the minor indentations of the sea-coast. The extent of shore-line is also measured in general outline, and includes such rivers only as have been triangulated.

Topography.—The length of the general coast is measured similarly to that under triangulation; but the shore-line under topography represents the whole water-line surveyed, including all the minor indentations, as represented on the plane-table sheets.

Records.—The total number of volumes of records given in the table is greater than the number now on hand, owing to the binding up of separate volumes.

Engraved Plates.—Progress sketches (averaging fourteen yearly) are not counted.

Library.—The number of volumes purchased and donated up to 1849 was 655.

It is to be remarked that the numbers appearing in the column of this table for the year immediately preceding that of its compilation are, in some cases, subject to be changed, more or less, in the succeeding Report, owing to data not being, at the time of compilation, fully turned into the office from the distant parties in the field.

APPENDIX No. 8.

General list of Coast Survey discoveries and developments to 1858, *inclusive.*

1. Temple's ledge, near Cape Small Point, Me., 1857.

2. Determination of the position of a sunken rock on which the steamer Daniel Webster struck, in Casco bay, on the evening of the 13th of October, 1856.

3. Determination of the dimensions of Alden's rock, near Cape Elizabeth, Me., 1854.

4. Fishing ledge off Kennebunk, Me., thoroughly sounded, 1858.

5. A rock one mile to the southward and westward of Boon island, with seventeen feet water. The sea breaks on it in heavy weather, 1858.

6. Development of Boon Island ledge, coast of Maine, 1858.

7. A rock off Cape Neddick, Me., determined in position, 1858.

8. A detached rock two-thirds of a mile northward and eastward of York ledge, Me., 1858.

9. Determination of the position of a rock more than a mile off the mouth of York river, Me.; bare at low tides and dangerous to coasters, 1858.

10. Development of Duck Island ledge, 1858.

11. A very dangerous rock, with only six and a half feet water, off the entrance to Portsmouth harbor, N. H., about four nautical miles eastward from the Whale's Back light, 1858.

12. A rock, with twelve feet at mean low water, about four miles and a third eastward of the Whale's Back, 1858.

13. Determination of rocks off Marblehead and Nahant, 1855.

14. A rock (not on any chart) in the inner harbor of Gloucester, Mass.; discovered in 1853.

15. A bank, ninety miles eastward of Boston, with about thirty-six fathoms of water, probably a knoll connected with Cashe's ledge, but with deep water between it and the ledge, 1853.

16. Boston harbor; Broad Sound channel thoroughly surveyed and marks recommended, 1848.

17. Several rocks in the fair channel way in Boston harbor entrance, 1854.

18. An extension of the sand-spit to the southward of Sunken ledge, Boston harbor, since the survey of 1847, 1858.

19. A bank (Stellwagen's bank) with ten and a half to fourteen and a half fathoms of water on it, at the entrance to Massachusetts bay, and serving as an important mark for approaching Boston and other harbors, 1854.

20. Extension of Stellwagen's bank to the southward and eastward some sixteen or seventeen square miles, enclosed by the twenty-fathom curve, 1855.

21. Changes in the vicinity of East harbor, (Cape Cod,) 1857.

22. A dangerous sunken ledge (Davis' ledge) to the eastward and in the neighborhood of Minot's ledge, 1854.

23. Development of a reef extending between Minot's and Scituate light, 1856.

24. A sunken rock, with only six feet on it at low water, off Webster's Flag-Staff, Massachusetts bay, 1856.

25. A dangerous rock near Saquish Head, entrance to Plymouth harbor, 1856.

26. Three rocks determined in position, partly bare at low water, off Manomet Point, Massachusetts bay, 1856.

27. Determination of a very dangerous rock off Indian hill, and four miles southward of Manomet Point, Massachusetts bay, with as little as six feet water on it, 1856.

28. Probable connection of George's bank and the deep-sea banks north and east of Nantucket, 1855.

29. The decrease of depth, with general permanence of form, of George's bank, off the coast of Massachusetts, 1857.

30. A shoal spot near Little George's bank, 1857.

31. Non-existence determined of "Clark's bank" and "Crab ledge," laid down on certain charts as distinct from an immense shoal ground off Cape Cod peninsula, 1856.

32. Nantucket shoals; Davis' New South shoals, six miles south of the old Nantucket South shoals, in the track of all vessels going between New York and Europe, or running along the coast from the eastern to the southern States, or to South America; discovered in 1846.

33. Two new shoals north and east of Nantucket; discovered in 1847.

34. Six new shoals near Nantucket; the outermost fourteen and a half miles from land, and with only ten feet water; discovered in 1848.

35. McBlair's shoals, off Nantucket; discovered in 1849.

36. The tidal currents of Nantucket shoals and the approaches, 1854.

37. Davis' bank, Nantucket shoals; discovered in 1848 and survey finished in 1851.

38. Fishing Rip, a large shoal extending north and south, about ten miles to the eastward of Davis' bank, and thirty miles from Nantucket, with four and a half fathoms: surveyed in 1852.

39. A ridge connecting Davis' New South shoal and Davis' bank; found in 1853.

40. A small bank or knoll with but five fathoms on it, about five miles east of Great Rip, with twelve fathoms between it and Davis' bank and Fishing Rip, the water gradually deepening outside of it to the northward and eastward beyond the limits of the series of shoals, 1853.

41. Discovery of Edward's shoal, one mile and seven-eighths southward of Nantucket light-boat, 1855.

42. Examination of the interference tides of Nantucket and Martha's Vineyard sounds, 1855.

43. The study of the tidal currents of the Vineyard and Nantucket sounds, 1857.

44. Contraction of the inlet at the north end of Monomoy island, and opening of a new entrance to Chatham harbor, 1853.

45. Muskeget channel; surveyed by Lieut. C. H. Davis in 1848 and Lieut. C. H. McBlair in 1850.

46. Discovery of two shoal spots, with twelve and thirteen feet water, eastward from Great and Little Round shoals, Nantucket sound, 1856.

47. Determination of two shoal spots near the northern extremity of Davis' bank, with fourteen and eighteen feet water, 1856.

48. Further development of Edward's shoal, three-fourths of a mile from the Southern Cross Rip, Nantucket sound, 1856.

49. Shoal sand ridges discovered northward of Great Point light, Nantucket sound, 1856.

50. Important changes in geographical feature at the southeastern end of Martha's Vineyard, Muskeget channel, 1856.

51. Numerous rocks in Martha's Vineyard sound, Long Island sound, and the various bays and harbors connected with them.

52. Luddington rocks, determined in position, about ten yards apart, a mile and a half (nautical) southwest, by compass, from New Haven light, 1858.

53. The tidal currents of Long Island sound, 1854.

54. The tidal currents of Hell Gate, 1857.

55. Least water on the Hell Gate rocks, determined by dragging, 1857.

56. Tidal currents in East river, N. Y., and surface and sub-currents investigated in New York harbor, the lower bay, and on the bar, 1858.

57. The currents of the great bay between Massachusetts, Rhode Island, Connecticut, New York, and New Jersey, 1855.

58. Gedney's channel into New York bay, having two feet more water than the old channels. Had the true depth of this channel been known in 1778, (then probably existing, as seen by comparing old and new charts,) the French fleet under Count D'Estaing would have passed into the bay and taken the assembled British vessels, 1845.

59. The changes in New York harbor, near New York city, between 1845 and 1858.

60. Increase of depth in Buttermilk channel, ascertained and made known in 1848 by survey of Lieut. D. D. Porter, U. S. N.

61. Shoal in the main ship-channel of New York harbor, 1855.

62. The tides of Hudson river, 1856.

63. Sandy Hook; its remarkable increase traced from the surveys of the topographical engineers and others, and by several successive special surveys made between 1844 and 1857.

64. Delaware bay; Blake's channel at the entrance, discovered in 1844; open when the eastern channel is closed by ice. This discovery has served to develop strikingly the resources of that portion of Delaware.

65. Blunt's channel, in Delaware bay.

66. Changes in the Delaware, near the Pea Patch, 1847.

67. The true extent and position of the dangerous shoals near Chincoteague inlet, Va., 1852.

68. Metomkin inlet, Va., shoaling from eleven to eight feet in the channel during 1852.

69. Two channels into Wachapreague inlet, Va.; one from the northward and the other from the eastward; both with seven feet water at low tide, 1852.

70. A shoal half a mile in extent, not put down on any chart, five and a half miles east from the north end of Paramore's island, Va. It has but four fathoms water on it, and nine fathoms around it, 1852.

71. Great Machipongo inlet, Va. Found to have a fine wide channel, with eleven feet water on the bar at low ebb, and fourteen at high tide. Good anchorage inside, in from two to eight fathoms. The best harbor between the Chesapeake and Delaware entrances, 1852.

72. Two shoals near the entrance to the Chesapeake; one four and three-quarter nautical miles SE. by E. from Smith's island light-house, with seventeen feet water upon it; the other E. by S. nearly seven and three-quarter miles from the same light, with nineteen and a half feet upon it, 1853.

73. Only three feet water upon the "Inner Middle," the shoal part of the Middle Ground, west of the "north channel," at the Chesapeake entrance, 1852.

74. A twenty-five fathom hole two and a half miles W.SW. from Tazewell triangulation point, eastern shore of the Chesapeake; all other charts give not more than sixteen fathoms in this vicinity.

75. A shoal at the mouth of the Great and Little Choptank, in Chesapeake bay, 1848.

76. The sounding and measurement of the bars in Rappahannock river, 1855.

77. The general permanence of the Bodkin channel and shoals in its vicinity, at the entrance of the Patapsco river, between 1844 and 1854.

78. A shoal (New Point shoal) in Chesapeake bay, with sixteen feet water on it, southeast from New Point Comfort light-house, off Mobjack bay, 1854.

79. Re-examination of York spit, Chesapeake bay, and least water determined, (nine feet,) 1855.

80. York river, Va., as a harbor, 1857.

81. A reconnaissance of the Wimble shoals, near Nag's head, coast of N. C., 1854.

82. Submarine range of hills beyond the Gulf Stream tracked from Cape Florida to Cape Lookout, 1855.

83. Deep water found on Diamond shoal, and a dangerous nine-feet shoal off Cape Hatteras, 1850.

84. A new channel, with fourteen feet water, into Hatteras inlet, formed during the year 1852, which is better and straighter than the old channel.

85. Changes at Hatteras and Ocracoke inlets, 1857.

86. The general permanence in depth on the bar of Beaufort, N. C., with the change of position of the channel, 1854.

87. Changes on the bar of Beaufort, N. C., 1857.

88. The well ascertained influence of prevailing winds in the movement of the bars at Cape Fear and New Inlet entrances, and the gradual shoaling of the main bar; the latter fact being of great importance to the extensive commerce seeking that harbor, 1853.

89. Changes in the main Western and New Inlet channels in Cape Fear, 1855.

90. Frying Pan shoals, off Cape Fear, N. C.; a channel of two and a half fathoms upwards of a mile wide, distant eleven nautical miles from Bald Head light-house, across the Frying Pan shoals. A channel extending from three to four miles from the point of Cape Fear to eight or eight and a half miles from it, with sufficient water at low tide to allow vessels drawing from nine to ten feet to cross safely. A channel at the distance of fourteen nautical miles from Bald Head light-house, one mile wide, with three and a half to seven fathoms water on it. The Frying Pan shoals extend twenty nautical miles from Bald Head light-house, and sixteen, seventeen, and eighteen feet water is found seventeen and eighteen nautical miles out from the light, 1851.

91. Shoaling of Cape Fear river bar thoroughly examined for purposes of improvement, 1852.

92. Changes of shore-line and hydrography determined at the Cape Fear entrances, N. C., 1858.

93. Changes of the Cape Fear bars and channels, 1857.

94. Changes at the entrance of Winyah bay and Georgetown harbor, and the washing away of Light-house point at the same entrance, 1853.

95. Maffitt's new channel, Charleston harbor, with the same depth of water as the ship channel, 1850.

96. The changes in Maffitt's channel, Charleston harbor, S. C., from 1852 to 1857.

97. Increase of depth developed in Maffitt's channel, Charleston harbor, S. C., 1858.

98. Changes in the main ship channel, Charleston harbor, 1855.

99. Changes in the channels at the entrance of Charleston harbor, 1852.

100. The remarkable discovery of continuous deep-sea soundings off Charleston, and of soundings in the depth of between four and five hundred fathoms beyond the Gulf Stream, 1853.

101. Development of the changes affecting the entrance to North Edisto river, S. C., 1856.

102. Discovery of a new channel between Martin's Industry (shoal) and the southeast breakers, Port Royal entrance, S. C., 1856.

103. Discovery of cold water at the bottom of the ocean below the Gulf Stream, along the coasts of N. and S. Carolina, Georgia, and Florida, 1853.

104. The discovery of the cold wall, alternate warm and cold bands, and various other features of the Gulf Stream, especially such as concern its surface and deep-sea temperatures, and its distribution relative to the shore and bottom of the ocean.

105. Various facts relative to the distribution of minute shells on the ocean bottom, of probable use to navigators for recognizing their positions.

106. Examination of Doboy, St. Simon's, and Cumberland entrances, 1855.

107. A shoal inside of the entrance to Amelia river, Fla., 1857.

108. Hetzel shoal, off Cape Cañaveral, Fla., 1850.

109. Temperature of 34° beneath the Gulf Stream, thirty-five miles east of Cape Florida, at a depth of three hundred and seventy fathoms, 1855.

110. A harbor of refuge (Turtle harbor) to the northward and westward of Carysfort lighthouse, Florida reef, with a depth of water of twenty-six feet at the entrance, 1854.

111. A new passage, with three fathoms water, across the Florida reef to Legare harbor, under Triumph reef, (latitude 25° 30′ N., longitude 80° 03′ W.,) which, if properly buoyed, will be valuable as a harbor of refuge, 1852.

112. A safe rule for crossing the Florida reef near Indian key, 1854.

113. A new channel into Key West harbor, 1850.

114. Cotidal lines for the Atlantic coast of the United States, 1854.

115. Rules for navigators in regard to the tidal currents of the coast, 1857.

116. Isaac shoal, near Rebecca shoal, Florida reef; not laid down on any chart, 1852.

117. Channel No. 4, a northwest entrance into Cedar Keys bay, 1852.

118. Directions for entering the harbor from Crystal river offing, western coast of Florida peninsula, 1856.

119. A new channel discovered, leading into St. George's sound, (Apalachicola, Fla.,) at the east end of Dog island, and anchorage connected with it, 1858.

120. Shoals near the East and West passes of St. George's sound, (Apalachicola, Fla.,) and a new channel found between St. George's and St. Vincent's islands, 1858.

121. Mobile bay entrance bar; in 1832 only seventeen feet at low water could be carried over it; in 1841 it had nineteen, and in 1847 it had twenty feet and three-quarters, as shown by successive surveys, 1847.

122. The diminution, almost closing, of the passage between Dauphine and Pelican islands, at the entrance of Mobile bay, 1853.

123. Horn Island channel, Mississippi sound, 1852.

124. The removal of the east spit of Petit Bois island, in the hurricane of 1852, opening a new communication between the Gulf and Mississippi sound, and the rendering of Horn Island Pass more easy of access by the removal of knolls, 1853.

125. The accurate determination of Ship shoal, off the coast of La., in connection with the site for a light-house, 1853.

126. An increase of depth of water on the bar of Pass Fourchon, La., 1854.

127. Deep-sea soundings in the Gulf of Mexico, 1855–'56.

128. Tidal phenomena of the Gulf, 1855.

129. The changes at Aransas Pass., Tex., as bearing on the question of a light-house site, 1853.

130. Co-tidal lines of the Gulf of Mexico, 1856.

131. On the effect of wind in disturbing the tides of the Gulf of Mexico, 1856.

132. Development of a bar at the entrance of San Diego bay, Cal., 1856.

133. A shoal inside of Ballast Point, San Diego bay, with only twelve and a half feet water; not laid down on any chart, 1852.

134. The determination of the position and soundings on Cortez bank, off the coast of Cal., 1853.

135. Complete hydrographic survey and determination of a point of rock on Cortez shoal, 1856.

136. Tides of San Diego, San Francisco, and Astoria, 1854.

137. The non-existence of San Juan island, usually laid among the Santa Barbara group, 1852.

138. Co-tidal lines of the Pacific coast, 1855.

139. Determination of Uncle Sam rock, 1855.

140. Investigation of the currents of Santa Barbara channel, 1856.

141. Red sand marking the inner entrance to the Golden Gate, 1855.

142. Channel sounded out between Yerba Buena and the Contra Costa, San Francisco bay, 1855.

143. A reef developed off the Contra Costa flats, San Francisco bay, Cal., 1858.

144. Whiting's rock, determined in position, near the "Brothers," at the entrance of San Pablo bay, Cal., 1858.

145. Further development of the extent of Commission rock, San Pablo bay, 1856.

146. Changes in the channel entrance of Humboldt bay or harbor, Cal., 1852 and 1853.

147. South channel, Columbia river, surveyed and made available to commerce, 1851. Changes of channels, their southward tendency, and a new three-fathom channel from Cape Disappointment, due west to open water, Columbia entrance, 1852; further changes, 1853.

148. The depth of water on the bars at the entrance of Rogue river and Umpquah river, Oregon, 1853.

149. A shoal at the northern entrance to the Strait of Rosario, W. T., giving good holding ground in thirty-three feet, 1854.

150. Boulder reef, northwest of Sinclair island, Rosario strait, partly bare at unusually low tides and surrounded by kelp, 1854.

151. A bank of three and a half fathoms, about a mile off the southwest point of Sucia island, at the northern entrance of Washington sound, W. T., 1858.

152. Belle rock, in the middle of Rosario strait, visible only at extreme low tides, 1854.

153. Entrance rock, at the entrance of Rosario strait, 1854.

154. Unit rock, in the Canal de Haro, W. T., visible only at extreme low tides, 1854.

155. A three-fathom shoal in the Strait of Juan de Fuca, off the southeast part of Bellevue or San Juan island, 1854.

156. Allen's bank, Admiralty inlet, W. T., 1857.

157. A five-fathom shoal, in the Strait of Juan de Fuca, between Canal de Haro and Rosario strait, 1854.

158. A bank in eleven fathoms, off the southern entrance to Canal de Haro, 1854.

159. The non-existence of two islands at the northern entrance of Canal de Haro, laid down on charts, 1853.

160. Various surveys and charts of small harbors on the Pacific coast of the U. S., and a continuous reconnaissance of the entire western coast and islands adjacent, a great part of which was imperfectly known.

161. Winds of the western coast of the U. S., 1857.

Additional list for 1859.

1. Only eighteen feet at mean low water found on the rock one mile to the southward of Seguin island, coast of Maine.

2. True position of the Hussey rock in Casco bay determined, correcting the erroneous one assigned on previous charts.

3. Determination of the position of the "Hue & Cry," the "Old Proprietor," and other dangers off Cape Elizabeth, Me.

4. Development of a rock off Ogunquit, bare at low tides, and very little known.

5. A fishing bank sounded out off Wood island, coast of Maine.

6. Huzzey's rock, south of Fletcher's neck, Me., determined in position.

7. Development of a four-fathom bank off Cape Porpoise, Me.

8. Determination of the position of a small rock with less than four feet at mean low water, near the channel, and in the vicinity of Great rock, Hyannis harbor, Mass.

9. The existence of a seventeen foot spot on the shoal off the battery, New York harbor; the extension of the shoal towards the channel, and the shoaling of the water generally between the shoal and shore.

10. The existence and character of sub-currents, ascertained as bearing on the physical conditions of New York harbor.

11. Changes developed in the shore-lines at the entrance of Little Annemessex river, Chesapeake bay.

12. Less water found off Cape Romain by preliminary examination, than has been heretofore assigned.

13. Further explorations in developing the character of the Gulf Stream in the Florida channel.

APPENDIX No. 9.

Letter to the Secretary of the Treasury, communicating the position of a sunken rock off Seguin island, coast of Maine, determined by Lieut. Comg. J. Wilkinson, U. S. N., assistant Coast Survey.

COAST SURVEY STATION,
Near Lane's Brook, Me., September 12, 1859.

SIR: I have the honor to communicate as additional to the information contained in my letter of August 30, which reported the development by Lieut. Comg. J. Wilkinson, U. S. N., assistant Coast Survey, of a less depth than has heretofore been assigned for a sunken rock off Seguin island, coast of Maine; the following bearing, etc., for the determination of its position, since furnished by that officer.

"*Bearing.*—From Seguin island light-house, S. 9° 30′ E., true; S. a little west by compass.

"*Distance.*—From south point of Seguin island, three-quarters of a nautical mile.

"*Range.*—Pond island light-house, just open on the southwest side of Seguin island."

The rock, as before stated, is surrounded by deep water, but has only eighteen feet on it at mean low tide, and lies in the track of vessels bound into the Kennebec river.

I would respectfully request authority to publish this letter in the usual form, as a notice to mariners.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. HOWELL COBB, *Secretary of the Treasury.*

APPENDIX No. 10.

Letter to the Secretary of the Treasury, communicating bearings and ranges from the true position of the Hussey rock in Casco bay, as determined by Lieut. Comg. John Wilkinson, U. S. N., assistant Coast Survey.

PHILADELPHIA, *October* 14, 1859.

SIR: I have the honor to report that in the progress of the soundings made this season in Casco bay, Me., by the party of Lieut. Comg. John Wilkinson, U. S. N., assistant Coast Survey, the true position of the Hussey rock has been determined and found to be more than a quarter of a nautical mile northwest of the position assigned hitherto on charts of the vicinity. The rock is small and has only twelve feet on it at mean low water. The following bearings and ranges from it are taken from the report of Lieut. Comg. Wilkinson:

"*Bearings.*—Middle of Green island, SE. ¼ E., by compass (S. 59° E. true.)

"Cape Elizabeth east light-house, SW. ¾ S., southerly by compass (S. 23° 30′ W. true.)

"Portland light-house, SW. by W. ¾ W., by compass (S. 52° W. true.)

"*Ranges.*—South end of Ram island and Portland light-house, in range.

"Poorduck church, three-quarters of a point open from White Head Bluff.

"School-house on Long Island, in range with the east end of Marsh island."

"A buoy that formerly marked the position of the Hussey rock parted from its moorings several years ago, and has not yet been replaced. Luckse's sound is a fine harbor of refuge for ships that are unable to work into Portland, and is resorted to by such, especially during the

winter when the wind is from the northward and westward. The Hussey lies directly in their track and should be marked by a buoy."

I would respectfully request that a copy of this communication may be fnrnished to the Light-House Board, and also authority for publishing it in the usual form as a notice to mariners.

Very respectfully, yours,

A. D. BACHE, *Supt. U. S. Coast Survey.*

Hon. HOWELL COBB, *Secretary of the Treasury.*

APPENDIX No. 11.

Letter to the Secretary of the Treasury reporting the development of a rock off Ogunquit, coast of Maine, by Lieut. Comg. Alexander Murray, U. S. N., assistant Coast Survey.

COAST SURVEY OFFICE, *November* 9, 1859.

SIR: I have the honor to communicate that in the progress of hydrographic operations on the coast of Maine, in August last, Lieut. Comg. Alexander Murray, U. S. N., assistant Coast Survey, developed the position of a rock, bare at low tide, off Ogunquit. It is about a mile and a half (nautical) from that village, and was unknown to the residents of the adjoining coast. The rock rises boldly from the bottom, from four to seven fathoms of water being found in its immediate vicinity, and in the opinion of Lieut. Comg. Murray should be marked by a spindle.

I would respectfully request that a copy of this letter may be furnished to the Light-house Board, and that authority may be given for publishing it in the usual form as a notice to mariners.

Very respectfully, yours,

A. D. BACHE,
Superintendent.

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 12.

Report of Lieut. Comg. John Wilkinson, U. S. N., assistant Coast Survey, on determining the position of a small rock at the entrance to Hyannis harbor, Massachusetts.

UNITED STATES COAST SURVEY STEAMER CORWIN,
Portland, Maine, July 29, 1859.

SIR: In obedience to your directions I have examined the locality in the main entrance to Hyannis harbor, where a rock was reported by Commander M. Smith, U. S. N., Light-house Inspector of the Second District, and succeeded in finding and determining its position. After running many lines and sweeping carefully over the ground within a hundred yards of the spar buoy, which has been placed to mark its supposed position or vicinity, without finding it, I obtained information which satisfied me that it was not situated in the channel, but near the

Great Rock. It is about eight feet square, and upon its crest there is a depth of three and a half feet at mean low water, increasing suddenly to twelve feet all around it.

The following are bearings and ranges from spar buoy "red No. 2:"

Centreville church spire, NW. by W. (westerly) true, NW. (westerly) by compass.

Hyannis west spire, north (easterly) true, N. by E. by compass.

Point Gammon light-house E.SE. true, SE. by E. ¼ E. by compass.

From the new rock the bearings are:

Centreville church spire, NW. by W. (westerly) true, NW. ¼ W. by compass.

Hyannis west spire, N. ¼ W. true, N. ¾ E. by compass.

Point Gammon light-house, SE. by E. ¾ E. true, SE. ¾ E. (easterly) by compass.

Great Rock spindle bears N.NW. ½ W. true, or N. by W. ½ W. by compass, and is distant two hundred yards.

Range.—The new rock and Great Rock spindle in range with two houses situated on the top of a low sand hill, distant five hundred yards from the foot of the western wharf, and two hundred yards from the beach.

The spar buoy "red No. 2" bears W. ¼ N. true, or W. by N. (northerly) by compass, and is distant three hundred and twenty-five yards.

Very respectfully, your obedient servant,

J. WILKINSON,
U. S. N., Assistant Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 13.

Letter of the Superintendent, addressed to the President of the New York Chamber of Commerce, with the report of Lieut. Comg. T. A. Craven, U. S. N., stating the result of an examination of the Battery shoal.

COAST SURVEY STATION,
Near Lane's Brook, Maine, September 27, 1859.

DEAR SIR: The report that one or more vessels had struck upon the shoal off the Battery, where it was generally supposed there was deep water, induced one of the pilot commissioners, George W. Blunt, esq., to call my attention to the desirableness of a resurvey of the shoal. It was assigned to Lieut. Comg. T. A. Craven, then assistant in the Coast Survey, who having been charged with the hydrography of New York harbor, for the commissioners on harbor encroachments, was familiar with every part of the shoal. His report, recently presented to me, gives in detail the changes which have occurred, and shows prospectively those which may be expected. It is important, and I therefore beg leave through you to call the attention of the Chamber of Commerce to it. The filling up between pier No. 1 and the Castle may readily be avoided by dredging, and no doubt the entire completion of the Battery work would retard the now rapid increase of the shoal. The shoal must, however, in a general way, be related to the new shore, line as the old was to the former shore, and thus the shoal while

changed in form must be pushed out to a distance, not equal, but corresponding to the addition to the shore-line of the Battery.

Yours, respectfully,

A. D. BACHE,
Superintendent U. S. Coast Survey.

PELATIAH PERIT, Esq.,
President Chamber of Commerce, New York.

Report of Lieut. Comg. T. A. Craven, U. S. N., to Prof. A. D. Bache, Superintendent Coast Survey, on the results of the resurvey of the shoal off the New York Battery.

NEW YORK, *September* 20, 1859.

SIR: In compliance with your directions in July last, I made an examination of the shoal off the Battery, New York, for the purpose of ascertaining what changes have taken place in that locality, and I herewith submit to you a map of the survey, scale $\frac{1}{5000}$, on which I have also had the soundings placed from the surveys of 1855 and 1856 for comparison.

The soundings of 1855 and 1856 are in red figures, and the curves are also distinctly drawn.

In order to make this discussion as explicit as possible, I divide the shoal into sections, and call your attention to each position separately; you will be much interested in observing the rapidity with which the shoal is accumulating, and with what regularity the deposits are being made:

Section I, from pier No. 1, North river, to Castle Garden.

In the angle formed by the line of the Battery and the pier there has been a very rapid filling up, the 3-fathom curve has been pushed outward eighty yards beyond the line of 1856; the 17 feet spot in the outer part of this section is extending towards pier No. 1, and there is an average decrease of three feet in depth throughout this section.

Section II extends to the 3-fathom curve of 1856.

In this portion of the shoal the change has been not less considerable than in the angle of pier No. 1. The 3-fathom curve was, in 1856, about seventy-five yards south of the Castle, it will be seen that it has extended towards the Castle wharf, and embraces a considerable area where formerly we had five fathoms; outside of this curve, we find in this section a general decrease of five feet in the depth.

Section III embraces the general shoal to the southeastern portion of the curve of 3 fathoms.

Excepting in the part already indicated, there has been no material change in the general contour of the shoal, but in following the curve to its southernmost point it will be seen that it has extended about one hundred feet to the southward.

Section IV extends from last section to the East river piers.

In calling your attention to this section, I will merely refer to the knoll lying about W.SW. from pier No. 1, East river. This knoll has eighteen feet water upon it, is very small, and has deep water outside and close to it; there is no change in depth on the knoll, but it is extending itself towards the north, and it will be seen that in that direction there is a decrease of two feet in the depth near the shoal.

East of this knoll there is no apparent change. Drawing a waved line from the last mentioned

knoll to the Castle Garden, you mark out the eddy waters of this part of the river; the currents of the two rivers meeting here at ebb and dividing at flood; this portion of the stream being too sluggish to carry off matters held in suspension, they are rapidly and constantly deposited.

Although from natural causes there must always have been a shoal off this point of the island, its accumulation has been evidently aided to a startling degree by the extension of the Battery. The currents which formerly flowed between the Castle Garden and the shore, made the greater portion of their deposit so near the shores as to cause no great injury to the operations of commerce, and the process of deposit was so gradual that it would have required an interval of many years ere the shoal would have seriously encroached on the waters of the bay, but the battery extension has already accomplished that which would have required a half century of the operations of nature, having pushed the shoal out as the shore line was changed.

In illustration of this assertion, we have but to look at the extraordinary heaping up of the earth in the angle formed by the Battery wall and pier No. 1; a heaping up, made by the ebb current of the North river, which as it comes around the pier is now turned back and formed into eddies by the Battery walls. This current formerly ran through the space now covered by the filling in, and poured the suspended matter into the East river, off White Hall, from whence it was carried away and distributed in the deep waters of the bay, but now a large portion of the sediment brought down by the ebb is doubtless filling in the space here with great rapidity; its effects are still more strongly visible in the section off the Castle, where we see changes of six and eight feet in the space of three years; this is due to the united efforts of the ebbs from the two rivers, and the time cannot be far distant when, unless dredging is resorted to, the entire space from the Castle to the head of pier No. 1 will be quite filled in.

In addition to the material damage done by thus forcing out into the stream a shoal which was heretofore of little consequence, it may safely be presumed that in filling in for the Battery extension very liberal supplies have been contributed to the shoal from the dirt carts, as without the security of a regular sea wall, immense quantities of the loose earth must from time to time be washed away and added to the shoal, and it is probable that when the slowly progressing enlargement is completed and the walls finished the changes will be less rapid.

The injury is now without other remedy than that of hastening to its completion a work which has proved so seriously disastrous to this already crowded part of the harbor, and by legislation preventing any extensions beyond the lines of the city as defined by the harbor commissioners.

I am, very respectfully, your obedient servant,

T. AUGS. CRAVEN,
Lieutenant Commanding.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

REPORT ON HARBOR ENCROACHMENTS.

Mr. G. W. Blunt presented the report of the committee on the subject of harbor encroachments, as follows:

The committee appointed to report upon the evils arising from the extension of the Battery, having been requested to extend their inquiries in order to ascertain if any and what other

abuses existed in the harbor, beg leave to report a few of the most important, and to propose a mode of abating or remedying them.

First in order among the abuses is that of an encroachment. The committee would mention West Washington Market, where five acres have been taken or filled in from the waters of the North river; likewise pier No. 51, North river, extended thirty-three feet beyond the exterior line established by law. These are the acts of the city authorities.

The Lowber extension at the foot of Fourteenth street, East river, and the piles just driven at the outer end of pier No. 29, East river, which pier was already some twenty-five feet beyond the established limits, are instances of encroachments by private parties.

Next in order is the sewerage. It has been ascertained that the slips in the harbor have been filled up nearly eighteen inches each year, by material discharged from the sewers, of which only four out of one hundred and ten discharge at the outer end of the piers, the remainder discharge into the still waters of the slips or basins, where there is no current to carry off the deposits.

Dumping grounds.

These are the places where the dirt swept from the streets of the city is deposited by order of the city inspector. They are eight in number, viz: At the foot of Vesey, Watts, Gansevoort, and Twenty-sixth streets, North river; Roosevelt, Stanton, Fifth, and Twenty-third streets, East river.

The dirt is continually being dropped into the waters of the harbor and filling up the slips, from the practice of heaping it up on the piers and bulkheads. During last month the pier at the foot of twenty-third street, East river, gave way from the accumulation of dirt upon it, and 3,000 cart loads were thus thrown into the river.

Remedies.

All parties encroaching upon the waters of the harbor, beyond the established limits, should be punished by sufficient penalties, and the harbor commissioners should have power to remove the encroachments at once, the offending parties to pay all expenses incurred in such removal. All new sewers should be carried to the outer ends of the piers, (which we believe to be the intention of the Croton Aqueduct department, which has charge of the construction of sewers,) and, where practicable, the termination of those now built should be changed so as to empty in like manner with the new ones. The cisterns at the corners of the streets communicating with the sewers should invariably be cleaned out weekly, which would be the great preventive of filling up the slips from the sewers.

No dumping should be permitted upon or near the piers or bulkheads, under a penalty; and the city inspectors should be required to have scows or other vessels provided and ready to receive the dirt from the carts, there being no good reason why dirt should have a preference over all other articles in the use of our piers and bulkheads.

The shore-line belonging to the State of New York, in the harbor of New York, under the control of the harbor commissioners, is over seventy miles in extent; no part of it can be extended into the rivers beyond the established limits, without doing injustice to the harbor and injustice to those who respect the law.

An instance is before us in the case of pier No. 51, North river, extended beyond the line as above stated; the comptroller of the city having allowed the lessee of pier 52 one thousand dollars reduction on his rent, on account of the damage done to him by the illegal extension.

The committee would recommend to the chamber that application be made to the legislature to legalize the remedies suggested in this report, and to the corporation of this city, that measures be taken to finish the extension of the Battery at once.

In closing their report, the committee would bear testimony to the great and continued interest shown by Professor A. D. Bache, Superintendent of the United States Coast Survey, for the preservation of our harbor, in having obtained and furnished to it all the information necessary to the forming of an intelligent opinion upon the subject under consideration.

GEORGE W. BLUNT.
ROBERT L. TAYLOR.
CHARLES H. MARSHALL.
ROBERT B. MINTURN.
ROYAL PHELPS.
JOHN D. JONES.
GEORGE OPDYKE.
RUSSELL STURGIS.

NEW YORK, *November* 1, 1859.

APPENDIX No. 14.

Tide tables for the use of navigators, prepared from the Coast Survey observations by A. D. Bache, Superintendent. (Furnished, by authority of the Treasury Department, to E. & G. W. Blunt, New York, and revised October, 1859.)

The following tables will enable navigators to ascertain the time and height of high and low water in some of the principal ports of the United States. The results are approximate, the observations being still in progress; but they may safely be used for practical purposes. The number of places of observation, and the time during which many of them have been made, are steadily on the increase as the Coast Survey advances.

The tides on the coast of the United States, on the Atlantic, Gulf of Mexico, and Pacific, are of three different classes. Those of the Atlantic are of the most ordinary type, ebbing and flowing twice in twenty-four hours. and having but moderate differences in height between the two successive high waters or low waters, one occurring before noon, the other after noon.

Those of the Pacific coast also ebb and flow twice during twenty-four hours; but the morning and afternoon tides differ very considerably in height, so much so that at certain periods a rock which has three feet and a half water upon it at low tide may be awash on the next succeeding low water. The intervals, too, between successive high and successive low waters may be very unequal.

The tides of ports in the Gulf of Mexico, west of Cape St. George, ebb and flow, as a rule, but once in twenty-four hours, or are single day tides. At particular parts of the month there are two small tides in the twenty-four hours. The rise and fall in all these ports is small. East of Cape St. George the rise and fall increases; there are two tides, as a rule, during the twenty-four hours, and the daily inequality referred to in the Pacific tides is large.

These peculiarities require a different way of treating the cases, and in some of them separate tables.

I propose to enable the navigator to find, from the Nautical Almanac and the following tables, the time and height of high and low water at any date within the ordinary range of difference produced by winds and other variable circumstances. I will endeavor to divest the matter of unfamiliar technical expressions as far as practicable, though, for shortness' sake, some such terms may be employed after defining them. The discussion of the Gulf tides has not been carried so far as to enable me to present the results in as definite a form as the others.

As is well known, the interval between the time of the moon's crossing the meridian (moon's transit) and the time of high water at a given place is nearly constant; that is, this interval varies between moderate limits, which can be assigned. The interval at full and change of the moon is known as the establishment of the port, and is ordinarily marked on the charts. As it is not generally the average of the interval during a month's tide, it is a less convenient and less accurate quantity for the use of the navigator than the average interval which is used on the Coast Survey charts, and is sometimes called the "mean" or "corrected establishment."* The following table gives the principal tidal quantities for the different ports named in the first column, where they are arranged under specific heads. The third column of the table gives the mean interval, in hours and minutes, between the moon's transit and the time of high water next after the transit; the fourth, the difference between the greatest and the least interval occurring in different parts of the month, (lunar.) A simple inspection of this column will show how important it is to determine these changes in many of the ports where they amount to more than half an hour, or to more than fifteen minutes from the average interval. The fifth, sixth, and seventh columns refer to the height of the tide. The fifth gives, in feet, the average rise and fall, or average difference between high and low water. The sixth gives the greatest difference, commonly known as the rise and fall of spring tides; and the seventh the least difference, known as the rise and fall of the neap tides.

The average duration of the flood or rising tide is given in the eighth column; of the ebb or falling tide in the ninth; and of the period during which the tide neither rises nor falls, or the "stand," in the tenth. The duration of the flood is measured from the middle of the stand at low water to the middle of the stand at high water; so that the whole duration from one high water to the next, or from one low water to the next, should be given by the sum of the numbers in the eighth and ninth columns. At most of these places given in the list a mark of reference has been established for the height of the tide. I have omitted the description of these marks (except in the following localities) as of no particular interest in this connection.

BENCH-MARKS.

Boston.—The top of the wall or quay at the entrance of the dry dock in the Charlestown navy yard is fourteen feet $\frac{76}{100}$ (or 14.76 feet) above mean low water.

New York.—The lower edge of a straight line cut in a stone wall, at the head of a wooden wharf on Governor's island, is thirteen feet $\frac{97}{100}$ (or 13.97 feet) above mean low water. The letters U. S. C. S. are cut in the same stone.

* This term was introduced by the Rev. Dr. Whewell, who has done so much for the investigation of the laws of the tides.

Old Point Comfort, Va.—A line cut in the wall of the light-house, one foot from the ground, on the SW. side, is eleven feet (11 feet) above mean low water.

Charleston, S. C.—The outer and lower edge of embrasure of gun No. 3, at Castle Pinckney, is ten feet $\frac{13}{100}$ (10.13 feet) above mean low water.

TABLE I.

Tide table for the coast of the United States.

PORT.	STATE.	INTV. BETWEEN TIME OF MOON'S TRANSIT AND TIME OF HIGH WATER.		RISE AND FALL.			MEAN DURATION OF—		
		Mean interval.	Diff. between greatest and least int'val.	Mean.	Spring tides.	Neap tides.	Flood tide.	Ebb tide.	Stand.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
COAST FROM PORTLAND TO NEW YORK.		h. m.	h. m.	Feet.	Feet.	Feet.	h. m.	h. m.	h. m.
Hanniwell's Point, Kennebec river	Maine	11 15	1 14	8.1	9.3	7.0	6 16	6 11	0 22
Portland	....do	11 25	0 44	8.9	9.9	7.6	6 14	6 12	20
Portsmouth	New Hampshire	11 23	53	8.6	9.9	7.2	6 22	6 7	21
Newburyport	Massachusetts	11 22	50	7.8	9.1	6.6	5 16	7 9	24
Rockport	....do	10 57	42	8.6	10.2	7.1	6 17	6 9	30
Salem	... do	11 13	50	9.2	10.6	7.6	6 19	6 6	6
Boston Light	....do	11 12	35	9.3	10.9	8.1	6 20	6 6	15
Boston	....do	11 27	43	10.0	11.3	8.5	6 13	6 13	9
Plymouth	....do	11 19	51	10.2	11.4	9.0	6 13	6 17	29
Wellfleet	... do	11 5	1 13	11.2	13.2	9.2	6 6	6 17	15
Provincetown*	....do	11 22	40	9.2	10.8	7.7	6 16	6 10	21
Monomoy	....do	11 58	37	3.8	5.3	2.6	6 25	5 59	36
Nantucket	....do	12 24	37	3.1	3.6	2.6	6 23	5 44	9
Hyannis	....do	12 22	30	3.2	3.9	1.8	6 44	5 41	9
Edgartown	....do	12 16	34	2.0	2.5	1.6	6 51	5 29	24
Holmes's Hole	....do	11 43	31	1.7	1.8	1.3	6 41	5 21	12
Tarpaulin Cove	....do	8 4	49	2.3	2.8	1.8	6 9	6 17	34
Wood's Hole, north side	....do	7 59	53	4.0	4.7	3.1	6 51	5 31	38
Wood's Hole, south side	....do	8 34	45	1.6	2.0	1.2	5 17	7 10	59
Menemsha Bight	....do	7 45	1 0	2.7	3.9	1.8	6 14	6 14	4
Quick's Hole, north side	....do	7 31	1 15	3.7	4.3	2.9	6 31	5 54	39
Quick's Hole, south side	....do	7 36	1 10	3.1	3.8	2.3	6 29	5 55	40
Cuttyhunk	....do	7 40	49	3.5	4.2	2.9	6 31	5 54	39
Kettle Cove	....do	7 48	1 0	4.3	5.0	3.7	6 17	6 4	29
Bird Island Light	....do	7 59	45	4.4	5.3	3.5	6 51	5 58	....
New Bedford entrance, (Dumpling Rock)	....do	7 57	41	3.8	4.6	2.8	6 50	5 33	42
Newport	Rhode Island	7 45	24	3.9	4.6	3.1	6 21	6 3	23
Point Judith	....do	7 32	46	3.1	3.7	2.6	6 12	6 10	1 0
Block Island	....do	7 36	41	2.8	3.5	2.0	6 23	6 2	5
Montauk Point, L. I.	New York	8 20	1 11	1.9	2.4	1.8	6 17	6 7	31
Sandy Hook	....do	7 29	47	4.8	5.6	4.0	6 10	6 15	21
New York	....do	8 13	43	4.3	5.4	3.4	6 0	6 25	28
HUDSON RIVER.									
Dobb's Ferry	New York	9 19	44	3.6	4.4	2.7	6 5	6 18	17
Tarrytown	....do	9 57	58	3.5	4.0	2.7	6 6	6 20	43
Verplanck's Point	....do	10 8	34	3.1	3.8	2.5	5 25	7 12	16
West Point	....do	11 2	37	2.7	3.2	2.0	5 28	7 10	20
Poughkeepsie	....do	12 34	54	3.2	3.9	2.4	5 41	6 44	22
Tivoli	....do	1 24	51	4.0	4.6	3.2	5 40	6 54	25
Stuyvesant	....do	3 23	48	3.8	4.4	3.0	5 18	7 2	31
Castleton	....do	4 29	55	2.7	3.0	2.3	5 1	7 23	20
Greenbush	....do	5 22	40	2.3	2.5	1.9	4 26	7 59	....

* From Major J. D. Graham's observations.

TABLE I—Continued.

PORT.	STATE.	Intv. between time of moon's transit and time of high water.		Rise and fall.			Mean duration of—		
		Mean interval.	Diff. between greatest and least int'val.	Mean.	Spring tides.	Neap tides.	Flood tide.	Ebb tide.	Stand.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
LONG ISLAND SOUND.		*h. m.*	*h. m.*	*Feet.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*h. m.*
Watch Hill	Rhode Island	9 0	0 23	2.7	3.1	2.4	6 25	5 56	0 14
Stonington	Connecticut	9 7	30	2.7	3.2	2.2	6 15	6 10	25
Little Gull Island	New York	9 38	1 07	2.5	2.9	2.3	6 1	6 21	37
New London	Connecticut	9 28	52	2.6	3.1	2.1	5 56	6 26	22
New Haven	...do	11 16	1 8	5.9	6.2	5.2	6 24	6 5	33
Bridgeport	...do	11 11	1 3	6.5	8 0	4.7	6 1	6 7	30
Oyster Bay, L. I.	New York	11 7	51	7.3	9.2	5.4	6 8	6 24	25
Sand's Point, L. I.	...do	11 13	31	7.7	8.9	6.4	5 55	6 30	14
New Rochelle	...do	11 22	32	7.6	8.6	6.6	5 51	6 35	12
Throg's Neck	...do	11 20	39	7.3	9.2	6.1	5 50	6 33	43
COAST OF NEW JERSEY.									
Cold Spring Inlet	New Jersey	7 32	51	4.4	5.4	3.6	6 8	6 18	19
Cape May Landing	...do	8 19	47	4.8	6.0	4.3	6 11	6 15	20
DELAWARE BAY AND RIVER.									
Delaware Breakwater	Delaware	8 0	50	3.5	4.5	3.0	6 15	6 6	26
Higbee's, Cape May	New Jersey	8 33	43	4.9	6.2	3.9	6 26	6 0	19
Egg Island Light	...do	9 4	51	6.0	7.0	5.1	5 52	6 27	36
Mahon's River	Delaware	9 52	48	5.9	6.9	5.0	6 11	6 11	26
Newcastle	...do	11 53	24	6.5	6.9	6.6	5 6	6 43	47
Philadelphia	Pennsylvania	13 44	44	6.0	6.8	5.1	4 52	7 6	15
CHESAPEAKE BAY AND RIVERS.									
Old Point Comfort	Virginia	8 17	60	2.5	3.0	2.0	6 1	6 25	14
Point Lookout	Maryland	12 58	45	1.4	1.9	0.7	5 59	6 19	35
Annapolis	...do	17 4	40	0.9	1.0	0.8	6 11	6 15	32
Bodkin Light	...do	18 8	48	1.0	1.3	0.8	5 23	7 8	15
Baltimore	...do	18 59	44	1.3	1.5	0.9	5 54	6 33	44
Washington	Dist. of Columbia	20 10	52	3.0	3.4	2.6	5 37	6 49	......
James River, (City Point)	Virginia	14 37	1 0	2.8	3.0	2.5	5 14	6 58	32
Richmond	...do	16 54	1 6	2.9	3.4	2.3..	4 53	7 31	35
Tappahannock	...do	12 58	46	1.6	1.9	1.3	5 21	7 6	....
COAST OF NORTH AND SOUTH CAROLINA, GEORGIA, AND FLORIDA.									
Hatteras inlet	North Carolina	7 4	57	2.0	2.2	1.8	6 7	6 7	50
Beaufort	...do	7 26	50	2.8	3.3	2.2	6 11	6 10	42
Bald Head	...do	7 26	34	4 3	5.0	3.4	6 18	6 17	31
Smithville	...do	7 19	38	4.5	5.5	3.8	6 1	6 26	26
Wilmington	...do	9 6	1 0	2.7	3.1	2.2	4 45	7 40	30
Georgetown entrance	South Carolina	7 56	42	3.8	4.7	2.7	6 4	6 19	35
Bull's Island Bay	...do	7 16	57	4.8	5.7	3.7	6 20	6 6	30
Charleston, (Custom-house wharf)	...do	7 26	48	5.1	6 0	4.1	6 19	6 7	33
St. Helena sound	...do.	7 8	1 0	5.9	7.4	4.4	6 13	6 12	23
Fort Pulaski, (Savannah entrance)	Georgia	7 20	40	7.0	8.0	5.9	5 49	6 35	26
Savannah, (Dry Dock wharf)	...do	8 13	51	6.5	7.6	5.5	5 4	7 22	14
Doboy Light-house	...do	7 33	55	6.6	7.8	5.4	6 2	6 20	....
St. Simon's	...do	7 43	46	6.8	8.2	5.4	6 10	6 16	20
Fort Clinch	Florida	7 53	1 6	5.9	6.7	5.3	6 9	6 17	....
St. John's River	...do	7 28	48	4.5	5.5	3.7	5 58	6 28	16
St. Augustine	...do	8 21	43	4.2	4.9	3.6	6 5	6 11	32
Cape Florida	...do	8 34	51	1.5	1.8	1.2	6 0	6 26	45
Indian Key	...do	8 18	49	1.8	2.4	1.2	6 36	5 48	19
Sand Key	...do	8 40	....	1.2	2.0	0.6	6 31	5 55	13

TABLE I—Continued.

PORT.	STATE.	Intv. between time of moon's transit and time of high water.		Rise and fall.			Mean duration of—		
		Mean interval.	Diff. between greatest and least int'val.	Mean.	Spring tides.	Neap tides.	Flood tide.	Ebb tide.	Stand.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
COAST OF NORTH AND SOUTH CAROLINA, GEORGIA, AND FLORIDA—Continued.		*h. m.*	*h. m.*	*Feet.*	*Feet.*	*Feet.*	*h. m.*	*h. m.*	*h. m.*
Key West	Florida	9 22	1 7	1.3	1.6	1.0	6 59	5 25	0 12
Tortugas	....do	9 56	1 32	1.2	1.5	0.6	6 43	5 40	....
Tampa Bay, (Egmont Key)	....do	11 21	1 33	1.4	1.8	1.0	6 36	6 11	43
Cedar Keys, (Depot Key)	....do	13 15	1 55	2.6	3.2	1.6	6 12	6 13	....
St. Mark's	....do	13 38	2 0	2.2	2.9	1.4	6 12	6 11	....
WESTERN COAST.									
San Diego	California	9 38	1 35	3.7	5.0	2.3	6 22	6 0	30
San Pedro	...do	9 39	1 48	3.7	4.7	2.2	6 18	6 5	30
Cuyler's Harbor	....do	9 25	1 2	3.7	5.1	2.8	6 13	6 5	....
San Luis Obispo	....do	10 8	1 52	3 6	4.8	2.4	6 25	5 58	....
Monterey	....do	10 22	49	3.4	4.3	2.5	6 31	6 2	35
South Farallone	.. do	10 37	1 16	3.6	4.4	2.8	6 18	6 9	....
San Francisco, (north beach)	....do	12 6	1 4	3.6	4.3	2.8	6 39	5 51	34
Mare Island, (San Francisco bay)	....do	13 40	1 15	4.8	5.2	4.1	6 13	6 7	....
Benicia	....do	14 10	1 0	4.5	5.1	3.7	6 26	5 59	....
Ravenswood	....do	12 36	57	6.3	7 3	4.9	6 15	6 11	....
Bodega	....do	11 17	1 54	3.6	4.7	2.7	6 19	5 59	....
Humboldt Bay	....do	12 2	1 11	4.4	5.5	3.5	6 19	6 0	.. ....
Port Orford	Oregon Territory	11 26	1 6	5.1	6.8	3.7	6 19	6 7	39
Astoria	....do	12 42	1 13	6.1	7.4	4.6	6 3	6 28	33
Nee-ah Harbor	Washington Terr	12 33	1 28	5.6	7.4	4.8	6 20	6 6	....
Port Townshend*	....do	3 49	1 3	4.6	5.5	4.0	6 34	5 52	....
Steilacoom*	....do	4 46	1 6	9.2	11.1	7.2	6 3	6 25	28
Semi-ah-moo Bay*	....do	4 50	1 2	5.7	6.6	4.8	6 11	6 19	26

* See remarks on page 144 and following.

NOTE.—The mean interval in column 3 has been increased by 12*h.* 26*m.* (half a mean lunar day) for some of the ports in Delaware river and Chesapeake bay, so as to show the succession of times from the mouth. Therefore, 12*h.* 26*m.* ought to be subtracted from the establishments which are greater than that quantity before using them.

The foregoing Table I gives the means of determining, roughly, the time and height of high water at the several ports named. The hour of transit of the moon preceding the time of high water is to be taken from the Almanac, and, the mean establishment being added, the time of high water results. Thus:

Example I.—It is required to find the time of high water at New York on November 5, 1854. The American Almanac gives 0*h.* 0*m.* as the time of transit of the moon on that day. The mean interval for New York, from Table I, column 3, is 8*h.* 13*m.*, which, as the transit was at 0*h.*, is, roughly, the time of high water. The moon being full, the height is that of spring tides of column 6, viz: 5.4 feet. If the soundings on the chart are reduced to low water spring tides, 5.4 feet are to be added to them to give the depth at high water. If the soundings are reduced to mean low water, the rise and fall of mean tides being 1.1 foot less than for springs, the rise or increase of depth will be half of this, or 0.6 of a foot less than 5.4 feet, which is 4.8 feet, or nearly four feet ten inches.

Example II.—Required the time of high water at Boston on January 23, 1851. From the

American Almanac we find the time of the moon's southing or transit, on that day, 5*h.* 18*m.* a. m., and from Table I the mean interval at Boston dry dock is 11*h.* 27*m.*

We have then	5*h.*	18*m.*	time of transit;
To which add	11	27	mean interval from Table I.
	16	45	time of high water, or 4*h.* 45*m.* p. m.

If the Greenwich Nautical Almanac is used, add 2*m.* to the time of transit of Greenwich for every hour of west longitnde, and its proportional part for less than an hour. It will suffice to take the half hour which may be over any number of hours, as the correction for less than this would be less than one minute, and need not be taken into account. Thus, Boston is 4*h.* 44*m.* west of Greenwich. The correction to be applied to the time of transit of the moon is, for the four hours, eight minutes, and for the 44 minutes, one minute. The time of transit on the date assumed in the preceding example is 17*h.* 9*m.* of the 22d, or 5*h.* 9*m.* a. m. of the 23d, to which add nine minutes; the correction just found gives 5*h.* 18*m.*, as before ascertained from the American Almanac.

In using the United States Nautical Almanac, in the astronomical part of which the transits of the moon are given for the meridian of Wasington, the corrections required may, in this first approximation for the Atlantic coast, be neglected. To find the time of the next following low water add from Table I the duration of ebb tide.

This gives 4*h.* 45*m.* p. m., time of high water.

6	13	duration of ebb tide from Table I.
10	58	p. m.

By subtracting the duration of flood tide we obtain the time of the preceding low water, 10*h.* 32*m.* a. m., recollecting that 4*h.* 45*m.* p. m. is the same as 16*h.* 45*m.* reckoned from midnight.

The height of this tide, corresponding to the transit of 5*h.*, will bring it nearly to a neap tide, and the rise and fall obtained from column 7, Table I, is 8.5 feet. The next following high water may be had by adding to the time of low water the duration of flood from Table I. Thus:

	10*h.*	58*m.*	p. m., time of low water January 23.
	6	13	duration of flood from Table I.
Sum	17	11	or 5*h.* 11*m.* on January 24.

On having found the time of high water, the time of the next following high water may be found by adding the duration of flood and ebb together, and their sum to the time of high water found, thus:

	6*h.*	13*m.*	duration of ebb tide, from Table I.
	6	13	duration of flood.
Sum	12	26	duration of whole tide.
	4	45	p. m., January 23, time of high water.
Sum	17	11	or 5*h.* 11*m.* a. m., 24th January, time of the next succeeding high water.

Subtracting the same quantity will give the time of the preceding high water, thus:

4*h.* 45*m.* p. m., or 16*h.* 45*m.* from midnight, is the time of high water.

12	26	duration of flood and ebb tide.
4	19	a. m. of the 23d for the preceding high water.

The duration of the flood and the ebb being reckoned from the middle of one stand or slack water to the middle of the next, the time of beginning of stand of ebb or flood will be found by subtracting half the duration of stand or slack water given by column 10, Table I, from the time of high or low water, and the time of the end of the stand of ebb or flood by adding the same. A nearer approximation to the times and heights of high water may be obtained by the use of Tables II and III.

TABLE II.

Interval between the time of moon's transit and the time of high water for different hours of transit, and for several different ports.

Time of moon's transit.	Boston, Mass.	New York, N. Y.	Philadelphia, Pa.	Old Pt. Comfort, Va.	Baltimore, Md.	Smithville, N. C.	Charleston, S. C.	Ft. Pulaski, Savannah, Ga.	Key West, Fla.	San Francisco, Cal.
h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
0 0	11 38	8 20	1 31	8 33	6 47	7 26	7 38	7 30	9 26	12 5
0 30	11 33	8 18	1 28	8 27	6 42	7 21	7 33	7 25	9 19	11 59
1 0	11 28	8 15	1 25	8 21	6 37	7 16	7 27	7 19	9 12	11 53
1 30	11 24	8 10	1 21	8 15	6 31	7 13	7 21	7 15	9 6	11 47
2 0	11 20	8 6	1 18	8 9	6 26	7 9	7 16	7 11	9 0	11 41
2 30	11 16	8 0	1 14	8 4	6 21	7 6	7 12	7 8	8 55	11 36
3 0	11 13	7 55	1 11	8 0	6 17	7 4	7 8	7 6	8 51	11 33
3 30	11 10	7 52	1 8	7 56	6 13	7 3	7 5	7 5	8 50	11 33
4 0	11 7	7 52	1 6	7 52	6 11	7 2	7 2	7 4	8 49	11 38
4 30	11 6	7 52	1 3	7 49	6 10	7 3	7 2	7 3	8 53	11 46
5 0	11 6	7 53	1 0	7 48	6 10	7 4	7 3	7 4	8 57	11 55
5 30	11 9	7 56	0 59	7 50	6 13	7 6	7 7	7 6	9 7	12 3
6 0	11 13	7 59	0 59	7 53	6 19	7 9	7 12	7 8	9 17	12 11
6 30	11 19	8 5	1 1	8 0	6 25	7 13	7 19	7 12	9 28	12 16
7 0	11 25	8 11	1 7	8 7	6 32	7 17	7 24	7 16	9 39	12 23
7 30	11 32	8 17	1 15	8 15	6 39	7 23	7 32	7 22	9 45	12 29
8 0	11 38	8 23	1 23	8 24	6 44	7 28	7 38	7 28	9 52	12 34
8 30	11 43	8 27	1 29	8 33	6 49	7 33	7 45	7 34	9 54	12 37
9 0	11 47	8 32	1 34	8 40	6 52	7 37	7 48	7 39	9 56	12 36
9 30	11 48	8 34	1 39	8 45	6 54	7 39	7 50	7 42	9 53	12 34
10 0	11 49	8 35	1 42	8 48	6 53	7 40	7 50	7 43	9 51	12 30
10 30	11 48	8 34	1 43	8 48	6 52	7 40	7 47	7 41	9 45	12 24
11 0	11 47	8 31	1 41	8 46	6 50	7 36	7 44	7 37	9 39	12 17
11 30	11 43	8 25	1 37	8 40	6 48	7 30	7 41	7 34	9 32	12 9

TABLE III.

Showing the rise and fall of tides, and corrections to be applied to determine the depth at high water of soundings on charts referred to mean low water, and to low water spring tides.

Time of moon's transit.	Boston, Mass.			New York, N. Y.			Philadelphia, Pa.			Old Point Comfort, Va.			Baltimore, Md.			Time of moon's transit.
	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	11.2	10.6	11.3	4.9	4.5	4.9	6.3	6.2	6.3	2.9	2.6	2.9	1.5	1.4	1.6	0
1	11.3	10.6	11.3	4.9	4.5	4.9	6.4	6.4	6.5	3.0	2.7	3.0	1.5	1.4	1.6	1
2	11.2	10.5	11.2	4.7	4.4	4.8	6.6	6.5	6.6	2.9	2.7	2.9	1.5	1.3	1.5	2
3	10.6	10.3	11.0	4.3	4.2	4 6	6.6	6.5	6.6	2.6	2.6	2.8	1.4	1.3	1.5	3
4	10.0	10.0	10.7	3.8	4.0	4.4	6.4	6.4	6.5	2.3	2.4	2.7	1.3	1.2	1.4	4
5	9.2	9.7	10.4	3.5	3 8	4.2	6.1	6.2	6.3	2.1	2.3	2.6	1.1	1.1	1.3	5
6	8.8	9.4	10.1	3.3	3.7	4.1	5.7	5.9	6.0	2.0	2.2	2.5	0.9	1.1	1.3	6
7	8.6	9.3	10.0	3.3	3.7	4.1	5.4	5.6	5.7	2.0	2.3	2.5	0.9	1.1	1.3	7
8	8.9	9.5	10.2	3.6	3.8	4.2	5.2	5.3	5.4	2.2	2.4	2.6	1.0	1.2	1.4	8
9	9.4	9.7	10.4	4.0	4.0	4.4	5.4	5.4	5.5	2.5	2.5	2.8	1.1	1.3	1.5	9
10	10.1	10.0	10.7	4.5	4.3	4.7	5.7	5.7	5.8	2.8	2.7	2.9	1.3	1.4	1.6	10
11	10.7	10.3	11.0	4.8	4.5	4.9	6.0	6.0	6.1	3.0	2.8	3.0	1.4	1.4	1.6	11

TABLE III—Continued.

Time of moon's transit	Smithville, N. C.			Charleston, S. C.			Fort Pulaski, Savannah entrance.			Key West, Fla.			San Francisco, Cal.			Time of moon's transit.
	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	5.2	4.8	5.1	6.0	5.5	6.0	7.8	7.4	7.8	1.6	1.4	1.6	4.5	4.0	4.4	0
1	5.1	4.8	5.1	5.9	5.5	5.9	7.9	7.4	7.9	1.6	1.4	1.6	3.9	3.7	4.1	1
2	5.0	4.7	5.0	5.7	5.4	5.8	7.6	7.3	7.7	1.5	1.4	1.5	3.7	3.6	4.1	2
3	4.6	4.5	4.8	5.3	5.2	5.6	7.1	7.0	7.5	1.4	1.3	1.5	3.5	3.5	4.0	3
4	4.3	4.4	4.7	4.7	4.9	5.4	6.5	6.7	7.2	1.2	1.2	1.4	3.1	3.3	3.8	4
5	4.0	4.3	4.6	4.4	4.8	5.2	6.1	6.5	7 0	1 0	1.1	1.3	2.8	3.1	3.6	5
6	3.8	4.2	4.5	4.2	4.6	5.1	5.8	6.4	6.8	1.0	1.1	1.3	2.7	3.1	3.6	6
7	3.8	4.1	4.4	4.3	4.7	5.1	6.0	6.5	6.9	1.0	1.1	1.3	3.0	3.3	3.7	7
8	4.0	4 2	4.5	4 5	4.8	5.3	6.4	6.7	7.1	1 1	1.2	1.3	3.4	3.5	3.9	8
9	4.3	4.3	4.6	5.0	5.0	5.5	6.9	6.9	7.4	1.3	1.3	1.4	3.8	3.6	4.1	9
10	4.7	4.6	4 9	5.5	5.3	5.8	7.4	7.0	7.6	1.4	1.3	1.5	4.0	3.8	4.2	10
11	5.0	4.7	5.0	5.9	5.5	5.9	7.8	7.2	7.8	1.6	1.4	1.6	4.2	3.8	4.3	11

In these, the variations in the interval between the moon's transit and high water are shown for some of the principal ports contained in Table I. These variations of intervals depend upon the age of the moon, and as they go through their values in half a lunar month, are known as the half-monthly inequality of interval. The table extends from the 0*h.* of transit, midnight of the calendar day, or full of the moon, to 11½ hours. The numbers for change of the moon correspond to those of 0*h.*, and for 13 hours (or 1*h.* p. m. of the calendar day) to 1 hour, and so on up to 23 hours. The ports for which the numbers are given are designated by the heading of the columns.

The mean interval, it will be seen, does not occur at full and change, but nearly two days afterwards, on the Atlantic coast. At Key West it occurs more nearly at full and change, and at San Francisco still more nearly.

The same remark applies to the heights; spring tides occur about two days after the full and change of the moon, and neaps two days after the first and last quarters. The use of this table of nearer approximation is quite as simple as that of Table I.

Rule to find the time of high water—Look in the Almanac for the time of moon's transit (or southing) for the date required. In the table corresponding to that time, will be found the number to be added to the time of transit.

Example III.—Required the time of high water at New York, October 1, 1856. Using the United States Nautical Almanac, we find the time of moon's transit 1*h.* 24*m.*, astronomical reckoning, or 1*h.* 24*m.* p. m., calendar time. From Table II, we have, under the heading of New York, for 1*h.* 30*m.*, (the nearest number to the 1*h.* 24*m.* in the table,) 8*h.* 10*m.*

Thus, to	1*h.*	24*m.*,	time of moon's transit,
Add	8	10	interval found from Table III.
The sum,	9	34	p. m., is the time of high water on the 1st of October, 1856.

If the sum of these numbers had exceeded twelve, the tide would have belonged to October 2, and we must have gone back to the transit of the day before, and computed with it, to obtain the tide of October 1.

Rule to find the height of high water.—Enter Table III, column 1, with the time of moon's transit. In the column headed with the name of the place, and marked A, will be found the rise and fall corresponding to the time of transit; in column B, the number to be added to

soundings on the chart, where the soundings are given for mean low water; in column C, the number to be added to charts of which the soundings are given for low water, spring tides.

In the foregoing example, (III,) the time of transit being between 1 and 2 hours, we find from Table III, the rise and fall of tides on 1st October, 1856, between 4.9 and 4.7; the number to be added to soundings given for mean low water 4.5 feet, (column B,) and for low water spring tides, (column C,) 4.9. feet.

Having found the time of high water, that of low water may be obtained nearly by adding the duration of ebb from column 9, Table I. The time of the next preceding low water may be found by subtracting the duration of flood from column 8, Table I. The time of the next following high water may be found by adding the duration of both flood and ebb; and of the next preceding high water, by subtracting the same duration of the whole tide.

Example IV.—To find the next high water following that of Example III.

The duration of flood, column 8, Table I, for New York, is 6*h.* 0*m.*; and of ebb, from column 9, is 6*h.* 25*m.*; the sum is 12*h.* 25*m.*

To	9*h.*	34*m.*	p. m., October 1, time of high water found,
Add	12	25	duration of flood and ebb.
Sum	21	59,	or 9*h.* 59*m.* a. m. of October 2, the time of the next high water.

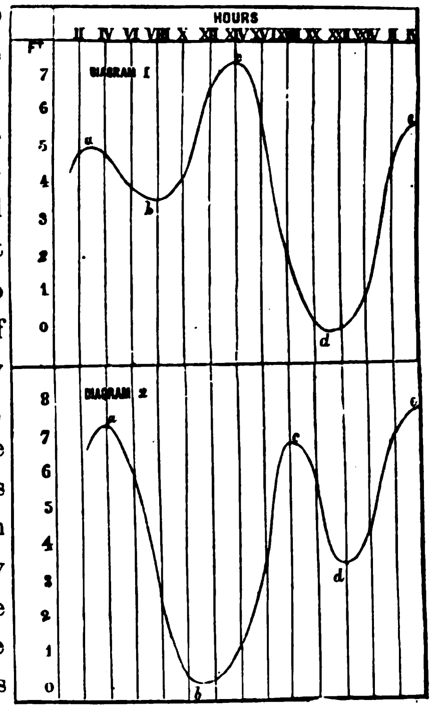
TIDES OF THE PACIFIC COAST.

On the Pacific coast there is, as a general rule, one large and one small tide during each day, the height of the two successive high waters occurring one a. m. the other p. m. of the same twenty-four hours, and the intervals from the next preceding transit of the moon are very different. The inequalities depend upon the moon's declination; they disappear near the time of the moon's declination being nothing, and are greatest about the time of its being greatest. The inequalities for low water are not the same as for high, though they disappear and have the greatest value at nearly the same times.

In Puget Sound the inequalities for the interval of high water and for the height of low water follow this rule, but those for the interval of low water and height of high water disappear about one day before the moon's declination is greatest, and are greatest about four or five days before the greatest declination.

When the moon's declination is north, the highest of the two tides of the twenty-four hours occurs at San Francisco about eleven and a half hours after the moon's southing, (transit;) and when the declination is south, the lowest of the two high tides occurs about that interval.

The lowest of the two low waters of the day is the one which follows next the highest high water. The nature of these tides will probably appear more plainly from the annexed diagrams. In them the height of the tide is set off at the side on a scale of feet, and the hours of the day are at the top. At 12 noon, for example, the tide-gauge marked 6.7 feet. Joining all the heights observed in the twenty-four hours, we have a curve like that marked in the figure.



The two high waters are a and c, and the two low waters b and d. If a is the high water, which occurs about twelve hours after the transit of the moon, when the declination is south, the ebb a b is quite small, and the high water, a, is much lower than the next high water, c. If the moon's declination is north, it is the large high water, a, of the second diagram, which occurs next after the transit, and about twelve hours from it. Tables IV and V, give the number to be added to the time of moon's transit to find the time of high water almost as readily as in the former case. They are of double entry, the time of transit being, as before, placed in the first column. The number of days from the day at which the moon had the greatest declination is arranged at the top of the table. Entering the first column with the time of transit, and following the line horizontally until we come under the column containing the days from the greatest declination, we find the number to be added to the time of transit to give the time of high water. If the moon's declination is south, Table IV is to be used; if north, Table V.

Tables IV to IX, inclusive, have been recomputed, using more complete data for the inequalities above referred to, and to those for San Francisco similar tables have been added for San Diego, Astoria, and Port Townshend. For the other places on the Western Coast given in Table I the following rules will give sufficiently close approximations.

To obtain the times of high or low water for San Pedro, Cuyler's harbor, and San Luis Obispo, compute first the time for San Diego, by Table IV, V, or VIII; then add to the time thus obtained 30 minutes, to obtain the time for San Luis Obispo, and subtract 13 minutes for Cuyler's harbor. At San Pedro the time of high or low water is sensibly the same as at San Diego.

For Monterey, South Farallon, Mare island, Benicia, Ravenswood, and Bodega, compute first the time for San Francisco, then subtract from the time thus obtained 1 h. 44 m. for Monterey, 1. h. 29 m. for the South Farallon, and 49 m. for Bodega, and add 34 m. for Mare island, 1 h. 4 m. for Benicia, and 30 m. for Ravenswood. For Thunderbolt bay, Port Orford, and Neeah harbor, compute first the time for Astoria, then subtract from it 40 m. for Humboldt bay, 1 h. 16 m. for Port Orford, and 9 m. for Neeah harbor.

For Steilacoom and Semi-ah-moo bay, compute first the time for Port Townshend, and add to it 57 m. for Steilacoom, and 1 h. for Semi-ah-moo. The approximation will be only a rough one for Steilacoom.

For the heights, Tables VI, VII, and IX for San Diego, can be used without change for San Pedro, Cuyler's harbor, and San Luis Obispo. These tables for San Francisco are also applicable to Monterey, South Farallon, and Bodega. For Mare island, add 1.2 foot, for Benicia, 0.9 foot, and for Ravenswood, 2.7 feet to the quantities for San Francisco.

For Humboldt bay, Port Orford, and Neeah harbor, the tables for Astoria may be used, subtracting 1.7 foot for Humboldt bay, and 1.0 foot for Port Orford. For Neeah harbor, the tables will give approximate results without change.

For Semi-ah-moo bay, add one foot to the quantities in the tables for Port Townshend. For Steilacoom, a rough approximation may be obtained by adding 4.6 feet to them.

TABLE IV.—SAN DIEGO.

Time of moon's transit.	South declination.—Days from moon's greatest declination.															Time of moon's transit.
	Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 0	9 25	9 40	9 52	10 3	10 12	10 20	10 25	10 29	10 29	10 25	10 19	10 10	10 0	9 47	9 30	0 0
0 30	9 15	9 30	9 42	9 53	10 2	10 10	10 15	10 19	10 19	10 15	10 9	10 0	9 50	9 27	9 20	0 30
1 0	9 8	9 23	9 35	9 46	9 55	10 3	10 8	10 12	10 12	10 8	10 2	9 53	9 43	9 30	9 13	1 0
1 30	9 1	9 16	9 28	9 39	9 48	9 56	10 1	10 5	10 5	10 1	9 55	9 46	9 36	9 23	9 6	1 30
2 0	8 54	9 9	9 21	9 32	9 41	9 49	9 54	9 58	9 58	9 54	9 48	9 39	9 29	9 16	8 59	2 0
2 30	8 49	9 4	9 16	9 27	9 36	9 44	9 49	9 53	9 53	9 49	9 43	9 34	9 24	9 11	8 54	2 30
3 0	8 48	9 3	9 15	9 26	9 35	9 43	9 48	9 52	9 52	9 48	9 42	9 33	9 23	9 10	8 53	3 0
3 30	8 48	9 3	9 15	9 26	9 35	9 43	9 48	9 52	9 52	9 48	9 42	9 33	9 23	9 10	8 53	3 30
4 0	8 52	9 7	9 19	9 30	9 39	9 47	9 52	9 56	9 56	9 52	9 46	9 37	9 27	9 14	8 57	4 0
4 30	8 56	9 11	9 23	9 34	9 43	9 51	9 56	10 0	10 0	9 56	9 50	9 41	9 31	9 18	9 1	4 30
5 0	9 15	9 30	9 42	9 53	10 2	10 10	10 15	10 19	10 19	10 15	10 9	10 0	9 50	9 37	9 20	5 0
5 30	9 37	9 52	10 4	10 15	10 24	10 32	10 37	10 41	10 41	10 37	10 31	10 22	10 12	9 59	9 42	5 30
6 0	9 55	10 10	10 22	10 33	10 42	10 50	10 55	10 59	10 59	10 55	10 49	10 40	10 30	10 17	10 0	6 0
6 30	10 12	10 27	10 39	10 50	10 59	11 7	11 12	11 16	11 16	11 12	11 6	10 57	10 47	10 34	10 17	6 30
7 0	10 18	10 33	10 45	10 56	11 5	11 13	11 18	11 22	11 22	11 18	11 12	11 3	10 53	10 40	10 23	7 0
7 30	10 20	10 35	10 47	10 58	11 7	11 15	11 20	11 24	11 24	11 20	11 14	11 5	10 55	10 42	10 25	7 30
8 0	10 22	10 37	10 49	11 0	11 9	11 17	11 22	11 26	11 26	11 22	11 16	11 7	10 57	10 44	10 27	8 0
8 30	10 24	10 39	10 51	11 2	11 11	11 19	11 24	11 28	11 28	11 24	11 18	11 9	10 59	10 46	10 29	8 30
9 0	10 18	10 33	10 45	10 56	11 5	11 13	11 18	11 22	11 22	11 18	11 12	11 3	10 53	10 40	10 23	9 0
9 30	10 10	10 25	10 37	10 48	10 57	11 5	11 10	11 14	11 14	11 10	11 4	10 55	10 45	10 32	10 15	9 30
10 0	10 0	10 15	10 27	10 38	10 47	10 55	11 0	11 4	11 4	11 0	10 54	10 45	10 35	10 22	10 5	10 0
10 30	9 53	10 8	10 20	10 31	10 40	10 48	10 53	10 57	10 57	10 53	10 47	10 38	10 28	10 15	9 58	10 30
11 0	9 45	10 0	10 12	10 23	10 32	10 40	10 45	10 49	10 49	10 45	10 39	10 30	10 20	10 7	9 50	11 0
11 30	9 36	9 51	10 3	10 14	10 23	10 31	10 36	10 40	10 40	10 36	10 30	10 21	10 11	9 58	9 41	11 30

TABLE V.—SAN DIEGO.

Time of moon's transit.	North declination.—Days from moon's greatest declination.															Time of moon's transit.
	Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 0	9 30	9 16	9 4	8 53	8 44	8 36	8 31	8 27	8 27	8 31	8 37	8 46	8 56	9 9	9 26	0 0
0 30	9 21	9 6	8 54	8 43	8 34	8 26	8 21	8 17	8 17	8 21	8 27	8 36	8 46	8 59	9 16	0 30
1 0	9 14	8 59	8 47	8 36	8 27	8 19	8 14	8 10	8 10	8 14	8 20	8 29	8 39	8 52	9 9	1 0
1 30	9 7	8 52	8 40	8 29	8 20	8 12	8 7	8 3	8 3	8 7	8 13	8 22	8 32	8 45	9 2	1 30
2 0	9 0	8 45	8 33	8 22	8 13	8 5	8 0	7 56	7 56	8 0	8 6	8 15	8 25	8 38	8 55	2 0
2 30	8 55	8 40	8 28	8 17	8 8	8 0	7 55	7 51	7 51	7 55	8 1	8 10	8 20	8 33	8 50	2 30
3 0	8 54	8 39	8 27	8 16	8 7	7 59	7 54	7 50	7 50	7 54	8 0	8 9	8 19	8 32	8 49	3 0
3 30	8 54	8 39	8 27	8 16	8 7	7 59	7 54	7 50	7 50	7 54	8 0	8 9	8 19	8 32	8 49	3 30
4 0	8 58	8 43	8 31	8 20	8 11	8 3	7 58	7 54	7 54	7 58	8 4	8 13	8 23	8 36	8 53	4 0
4 30	9 2	8 47	8 35	8 24	8 15	8 7	8 2	7 58	7 58	8 2	8 8	8 17	8 27	8 40	8 57	4 30
5 0	9 21	9 6	8 54	8 43	8 34	8 26	8 21	8 17	8 17	8 21	8 27	8 36	8 46	8 59	9 16	5 0
5 30	9 43	9 28	9 16	9 5	8 56	8 48	8 43	8 39	8 39	8 43	8 49	8 58	9 8	9 21	9 38	5 30
6 0	10 1	9 46	9 34	9 23	9 14	9 6	9 1	8 57	8 57	9 1	9 7	9 16	9 26	9 39	9 56	6 0
6 30	10 18	10 3	9 51	9 40	9 31	9 23	9 18	9 14	9 14	9 18	9 24	9 33	9 43	9 56	10 13	6 30
7 0	10 24	10 9	9 57	9 46	9 37	9 29	9 24	9 20	9 20	9 24	9 30	9 39	9 49	10 2	10 19	7 0
7 30	10 26	10 11	9 59	9 48	9 39	9 31	9 26	9 22	9 22	9 26	9 32	9 41	9 51	10 4	10 21	7 30
8 0	10 28	10 13	10 1	9 50	9 41	9 33	9 28	9 24	9 24	9 28	9 34	9 43	9 53	10 6	10 23	8 0
8 30	10 30	10 15	10 3	9 52	9 48	9 35	9 30	9 26	9 26	9 30	9 36	9 45	9 55	10 8	10 25	8 30
9 0	10 24	10 9	9 57	9 46	9 37	9 29	9 24	9 20	9 20	9 24	9 30	9 39	9 49	10 2	10 19	9 0
9 30	10 16	10 1	9 49	9 38	9 29	9 21	9 16	9 12	9 12	9 16	9 22	9 31	9 41	9 54	10 11	9 30
10 0	10 6	9 51	9 39	9 28	9 19	9 11	9 6	9 2	9 2	9 6	9 12	9 21	9 31	9 44	10 1	10 0
10 30	9 59	9 44	9 32	9 21	9 12	9 4	8 59	8 55	8 55	8 59	9 5	9 14	9 24	9 37	9 54	10 30
11 0	9 51	9 36	9 24	9 13	9 4	8 56	8 51	8 47	8 47	8 51	8 57	9 6	9 16	9 29	9 46	11 0
11 30	9 42	9 27	9 15	9 4	8 55	8 47	8 42	8 38	8 38	8 42	8 48	8 57	9 7	9 20	9 37	11 30

TABLE IV.—SAN FRANCISCO.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.															Time of moon's transit.
	B· fore—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 00	11 43	11 59	12 15	12 33	12 50	13 03	13 17	13 20	13 19	13 14	13 07	12 57	12 45	12 32	12 18	0 00
0 30	11 37	11 53	12 09	12 27	12 44	12 57	13 11	13 14	13 13	13 08	13 01	12 51	12 39	12 26	12 12	0 30
1 00	11 31	11 47	12 03	12 21	12 38	12 51	13 05	13 08	13 07	13 02	12 55	12 45	12 33	12 20	12 06	1 00
1 30	11 25	11 41	11 57	12 15	12 32	12 45	12 59	13 02	13 01	12 56	12 49	12 39	12 27	12 14	12 00	1 30
2 00	11 19	11 35	11 51	12 09	12 26	12 39	12 53	12 56	12 55	12 50	12 43	12 33	12 21	12 06	11 54	2 00
2 30	11 14	11 30	11 46	12 04	12 21	12 34	12 48	12 51	12 50	12 45	12 38	12 28	12 16	12 03	11 49	2 30
3 00	11 11	11 27	11 43	12 01	12 18	12 31	12 45	12 48	12 47	12 42	12 35	12 25	12 13	12 00	11 46	3 00
3 30	11 11	11 27	11 43	12 01	12 18	12 31	12 45	12 48	12 47	12 42	12 35	12 25	12 13	12 00	11 46	3 30
4 00	11 16	11 32	11 48	12 06	12 23	12 36	12 50	12 53	12 52	12 47	12 40	12 30	12 18	12 05	11 51	4 00
4 30	11 24	11 40	11 56	12 14	12 31	12 44	12 58	13 01	13 00	12 55	12 48	12 38	12 26	12 13	11 59	4 30
5 00	11 33	11 49	12 05	12 23	12 40	12 53	13 07	13 10	13 09	13 04	12 57	12 47	12 35	12 22	12 08	5 00
5 30	11 41	11 57	12 13	12 31	12 48	13 01	13 15	13 18	13 17	13 12	13 05	12 55	12 43	12 30	12 16	5 30
6 00	11 49	12 05	12 21	12 39	12 56	13 09	13 23	13 26	13 25	13 20	13 13	13 03	12 51	12 38	12 24	6 00
6 30	11 54	12 10	12 26	12 44	13 01	13 14	13 28	13 31	13 30	13 25	13 18	13 08	12 56	12 43	12 29	6 30
7 00	12 01	12 17	12 33	12 51	13 08	13 21	13 35	13 38	13 37	13 32	13 25	13 15	13 03	12 50	12 36	7 00
7 30	12 07	12 23	12 39	12 57	13 14	13 27	13 41	13 44	13 43	13 38	13 31	13 21	13 09	12 56	12 42	7 30
8 00	12 12	12 28	12 44	13 02	13 19	13 32	13 46	13 49	13 48	13 43	13 36	13 26	13 14	13 01	12 47	8 00
8 30	12 15	12 31	12 47	13 05	13 22	13 35	13 49	13 52	13 51	13 46	13 39	13 29	13 17	13 04	12 50	8 30
9 00	12 14	12 30	12 46	13 04	13 21	13 34	13 48	13 51	13 50	13 45	13 38	13 28	13 16	13 03	12 49	9 00
9 30	12 12	12 28	12 44	13 02	13 19	13 32	13 46	13 49	13 48	13 43	13 36	13 26	13 14	13 01	12 47	9 30
10 00	12 08	12 24	12 40	12 58	13 15	13 28	13 42	13 45	13 44	13 39	13 32	13 22	13 10	12 57	12 43	10 00
10 30	12 02	12 18	12 34	12 52	13 09	13 22	13 36	13 39	13 38	13 33	13 26	13 16	13 04	12 51	12 37	10 30
11 00	11 55	12 11	12 27	12 45	13 02	13 15	13 29	13 32	13 31	13 26	13 19	13 09	12 57	12 44	12 30	11 00
11 30	11 47	12 03	12 19	12 37	12 54	13 07	13 21	13 24	13 23	13 18	13 11	13 01	12 49	12 36	12 22	11 30

TABLE V.—SAN FRANCISCO.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.															Time of moon's transit.
	Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 00	12 27	12 11	11 55	11 37	11 20	11 07	10 53	10 50	10 51	10 56	11 03	11 13	11 25	11 38	11 52	0 00
0 30	12 21	12 05	11 49	11 31	11 14	11 01	10 47	10 44	10 45	10 50	10 57	11 07	11 19	11 32	11 46	0 30
1 00	12 15	11 59	11 43	11 25	11 08	10 55	10 41	10 38	10 39	10 44	10 51	11 01	11 13	11 26	11 40	1 00
1 30	12 09	11 53	11 37	11 19	11 02	10 49	10 35	10 32	10 33	10 38	10 45	10 55	11 07	11 20	11 34	1 30
2 00	12 03	11 47	11 31	11 13	10 56	10 43	10 29	10 26	10 27	10 32	10 39	10 49	11 01	11 14	11 28	2 00
2 30	11 58	11 42	11 26	11 08	10 51	10 38	10 24	10 21	10 22	10 27	10 34	10 44	10 56	11 09	11 23	2 30
3 00	11 55	11 39	11 23	11 05	10 48	10 35	10 21	10 18	10 19	10 24	10 31	10 41	10 53	11 06	11 20	3 00
3 30	11 55	11 39	11 23	11 05	10 48	10 35	10 21	10 18	10 19	10 24	10 31	10 41	10 53	11 06	11 20	3 30
4 00	12 00	11 44	11 28	11 10	10 53	10 40	10 26	10 23	10 24	10 29	10 36	10 46	10 58	11 11	11 25	4 00
4 30	12 08	11 52	11 36	11 18	11 01	10 48	10 34	10 31	10 32	10 37	10 44	10 54	11 06	11 19	11 33	4 30
5 00	12 17	12 01	11 45	11 27	11 10	10 57	10 43	10 40	10 41	10 46	10 53	11 03	11 15	11 28	11 42	5 00
5 30	12 25	12 09	11 53	11 35	11 18	11 05	10 51	10 48	10 49	10 54	11 01	11 11	11 23	11 36	11 50	5 30
6 00	12 33	12 17	12 01	11 43	11 26	11 13	10 59	10 56	10 57	11 02	11 09	11 19	11 31	11 44	11 58	6 00
6 30	12 38	12 22	12 06	11 48	11 31	11 18	11 04	11 01	11 02	11 07	11 14	11 24	11 36	11 49	12 03	6 30
7 00	12 45	12 29	12 13	11 55	11 38	11 25	11 11	11 08	11 09	11 14	11 21	11 31	11 43	11 56	12 10	7 00
7 30	12 51	12 35	12 19	12 01	11 44	11 31	11 17	11 14	11 15	11 20	11 27	11 37	11 49	12 02	12 16	7 30
8 00	12 56	12 40	12 24	12 06	11 49	11 36	11 22	11 19	11 20	11 25	11 32	11 42	11 54	12 07	12 21	8 00
8 30	12 59	12 43	12 27	12 09	11 52	11 39	11 25	11 22	11 23	11 28	11 35	11 45	11 57	12 10	12 24	8 30
9 00	12 58	12 42	12 26	12 08	11 51	11 38	11 24	11 21	11 22	11 27	11 34	11 44	11 56	12 09	12 23	9 00
9 30	12 56	12 40	12 24	12 06	11 49	11 36	11 22	11 19	11 20	11 25	11 32	11 42	11 54	12 07	12 21	9 30
10 00	12 52	12 36	12 20	12 02	11 45	11 32	11 18	11 15	11 16	11 21	11 28	11 38	11 50	12 03	12 17	10 00
10 30	12 46	12 30	12 14	11 56	11 39	11 26	11 12	11 09	11 10	11 15	11 22	11 32	11 44	11 57	12 11	10 30
11 00	12 39	12 23	12 07	11 49	11 32	11 19	11 05	11 02	11 03	11 08	11 15	11 25	11 37	11 50	12 04	11 00
11 30	12 31	12 15	11 59	11 41	11 24	11 11	10 57	10 54	10 55	11 00	11 07	11 17	11 29	11 42	11 56	11 30

TABLE IV.—ASTORIA.

SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.

Time of moon's transit.	Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7	Time of moon's transit.
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m	h. m.	h. m.	h. m.
0 0	12 42	12 55	13 5	13 18	13 28	13 38	13 41	13 45	13 46	13 44	13 40	13 34	13 24	13 14	13 2	0 0
0 30	12 36	12 49	12 59	13 12	13 22	13 32	13 35	13 39	13 40	13 38	13 34	13 28	13 18	13 8	12 56	0 30
1 0	12 29	12 42	12 52	13 5	13 15	13 25	13 28	13 32	13 33	13 31	13 27	13 21	13 11	13 1	12 49	1 0
1 30	12 23	12 36	12 46	12 59	13 9	13 19	13 22	13 26	13 27	13 25	13 21	13 15	13 5	12 55	12 43	1 30
2 0	12 15	12 28	12 38	12 51	13 1	13 11	13 14	13 18	13 19	13 17	13 13	13 7	12 57	12 47	12 35	2 0
2 30	12 9	12 22	12 32	12 45	12 55	13 5	13 8	13 12	13 13	13 11	13 7	13 1	12 51	12 41	12 29	2 30
3 0	12 3	12 16	12 26	12 39	12 49	12 59	13 2	13 6	13 7	13 5	13 1	12 55	12 45	12 35	12 23	3 0
3 30	11 58	12 11	12 21	12 34	12 44	12 54	12 57	13 1	13 2	13 0	12 56	12 50	12 40	12 30	12 18	3 30
4 0	11 57	12 10	12 20	12 33	12 43	12 53	12 56	13 0	13 1	12 59	12 55	12 49	12 39	12 29	12 17	4 0
4 30	12 0	12 13	12 23	12 36	12 46	12 56	12 59	13 3	13 4	13 2	12 58	12 52	12 42	12 32	12 20	4 30
5 0	12 8	12 21	12 31	12 44	12 54	13 4	13 7	13 11	13 12	13 10	13 6	13 0	12 50	12 40	12 28	5 0
5 30	12 15	12 28	12 38	12 51	13 1	13 11	13 14	13 18	13 19	13 17	13 13	13 7	12 57	12 47	12 35	5 30
6 0	12 25	12 38	12 48	13 1	13 11	13 21	13 24	13 28	13 29	13 27	13 23	13 17	13 7	12 57	12 45	6 0
6 30	12 36	12 49	12 59	13 12	13 22	13 32	13 35	13 39	13 40	13 38	13 34	13 28	13 18	13 8	12 56	6 30
7 0	12 45	12 58	13 8	13 21	13 31	13 41	13 44	13 48	13 49	13 47	13 43	13 37	13 27	13 17	13 5	7 0
7 30	12 55	13 8	13 18	13 31	13 41	13 51	13 54	13 58	13 59	13 57	13 53	13 47	13 37	13 27	13 15	7 30
8 0	13 3	13 16	13 26	13 39	13 49	13 59	14 2	14 6	14 7	14 5	14 1	13 55	13 45	13 35	13 23	8 0
8 30	13 8	13 21	13 31	13 44	13 54	14 4	14 7	14 11	14 12	14 10	14 6	14 0	13 50	13 40	13 28	8 30
9 0	13 10	13 23	13 33	13 46	13 56	14 6	14 9	14 13	14 14	14 12	14 8	14 2	13 52	13 42	13 30	9 0
9 30	13 9	13 22	13 32	13 45	13 55	14 5	14 8	14 12	14 13	14 11	14 7	14 1	13 51	13 41	13 29	9 30
10 0	13 5	13 18	13 28	13 41	13 51	14 1	14 4	14 8	14 9	14 7	14 3	13 57	13 47	13 37	13 25	10 0
10 30	12 59	13 12	13 22	13 35	13 45	13 55	13 58	14 2	14 3	14 1	13 57	13 51	13 41	13 31	13 19	10 30
11 0	12 53	13 6	13 16	13 29	13 39	13 49	13 52	13 56	13 57	13 55	13 51	13 45	13 35	13 25	13 13	11 0
11 30	12 46	12 59	13 9	13 22	13 32	13 42	13 45	13 49	13 50	13 48	13 44	13 38	13 28	13 18	13 6	11 30

TABLE V.—ASTORIA.

NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.

Time of moon's transit.	Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7	Time of moon's transit.
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 0	13 10	12 57	12 47	12 34	12 24	12 14	12 11	12 7	12 6	12 8	12 12	12 18	12 28	12 38	12 50	0 0
0 30	13 4	12 51	12 41	12 28	12 18	12 8	12 5	12 1	12 0	12 2	12 6	12 12	12 22	12 32	12 44	0 30
1 0	12 57	12 44	12 34	12 21	12 11	12 1	11 58	11 54	11 53	11 55	11 59	12 5	12 15	12 25	12 37	1 0
1 30	12 51	12 38	12 28	12 15	12 5	11 55	11 52	11 48	11 47	11 49	11 53	11 59	12 9	12 19	12 31	1 30
2 0	12 43	12 30	12 20	12 7	11 57	11 47	11 44	11 40	11 39	11 41	11 45	11 51	12 1	12 11	12 23	2 0
2 30	12 37	12 24	12 14	12 1	11 51	11 41	11 38	11 34	11 33	11 35	11 39	11 45	11 55	12 5	12 17	2 30
3 0	12 31	12 18	12 8	11 55	11 45	11 35	11 32	11 28	11 27	11 29	11 33	11 39	11 49	11 59	12 11	3 0
3 30	12 26	12 13	12 3	11 50	11 40	11 30	11 27	11 23	11 22	11 24	11 28	11 34	11 44	11 54	12 6	3 30
4 0	12 25	12 12	12 2	11 49	11 39	11 29	11 26	11 22	11 21	11 23	11 27	11 33	11 43	11 53	12 5	4 0
4 30	12 28	12 15	12 5	11 52	11 42	11 32	11 29	11 25	11 24	11 26	11 30	11 36	11 46	11 56	12 8	4 30
5 0	12 36	12 23	12 13	12 0	11 50	11 40	11 37	11 33	11 32	11 31	11 38	11 44	11 54	12 4	12 16	5 0
5 30	12 43	12 30	12 20	12 7	11 57	11 47	11 44	11 40	11 39	11 41	11 45	11 51	12 1	12 11	12 23	5 30
6 0	12 53	12 40	12 30	12 17	12 7	11 57	11 54	11 50	11 49	11 51	11 55	12 1	12 11	12 21	12 33	6 0
6 30	13 4	12 51	12 41	12 28	12 18	12 8	12 5	12 1	12 0	12 2	12 6	12 12	12 22	12 32	12 44	6 30
7 0	13 13	13 0	12 50	12 37	12 27	12 17	12 14	12 10	12 9	12 11	12 15	12 21	12 31	12 41	12 53	7 0
7 30	13 23	13 10	13 0	12 47	12 37	12 27	12 24	12 20	12 19	12 21	12 25	12 31	12 41	12 51	13 3	7 30
8 0	13 31	13 18	13 8	12 55	12 45	12 35	12 32	12 28	12 27	12 29	12 33	12 39	12 49	12 59	13 11	8 0
8 30	13 36	13 23	13 13	13 0	12 50	12 40	12 37	12 38	12 32	12 34	12 38	12 44	12 54	13 4	13 16	8 30
9 0	13 38	13 25	13 15	13 2	12 52	12 42	12 39	12 35	12 34	12 36	12 40	12 46	12 56	13 6	13 18	9 0
9 30	13 37	13 24	13 14	13 1	12 51	12 41	12 38	12 34	12 33	12 35	12 39	12 45	12 55	13 5	13 17	9 30
10 0	13 33	13 20	13 10	12 57	12 47	12 37	12 34	12 30	12 29	12 31	12 35	12 41	12 51	13 1	13 13	10 0
10 30	13 27	13 14	13 4	12 51	12 41	12 31	12 28	12 24	12 23	12 25	12 29	12 35	12 45	12 55	13 7	10 30
11 0	13 21	13 8	12 58	12 45	12 35	12 25	12 22	12 18	12 17	12 19	12 23	12 29	12 39	12 49	13 1	11 0
11 30	13 14	13 1	12 51	12 38	12 28	12 18	12 15	12 11	12 10	12 12	12 16	12 22	12 32	12 42	12 54	11 30

TABLE IV.—PORT TOWNSHEND.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.															Time of moon's transit.
	Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 0	3 45	3 21	2 51	2 2	1 32	1 13	1 26	1 44	2 2	2 21	2 42	2 57	3 15	3 33	3 45	0 0
0 30	3 38	3 14	2 44	1 55	1 25	1 6	1 19	1 37	1 55	2 14	2 35	2 50	3 8	3 26	3 38	0 30
1 0	3 32	3 8	2 38	1 49	1 19	1 0	1 13	1 31	1 49	2 8	2 29	2 44	3 2	3 20	3 32	1 0
1 30	3 26	3 2	2 32	1 43	1 13	0 54	1 7	1 25	1 43	2 2	2 23	2 38	2 56	3 14	3 26	1 30
2 0	3 21	2 57	2 27	1 38	1 8	0 49	1 2	1 20	1 38	1 57	2 18	2 33	2 51	3 9	3 21	2 0
2 30	3 18	2 54	2 24	1 35	1 5	0 46	0 59	1 17	1 35	1 54	2 15	2 20	2 48	3 6	3 18	2 30
3 0	3 16	2 52	2 22	1 33	1 3	0 44	0 57	1 15	1 33	1 52	2 13	2 28	2 46	3 4	3 16	3 0
3 30	3 17	2 53	2 23	1 34	1 4	0 45	0 58	1 16	1 34	1 53	2 14	2 29	2 47	3 5	3 17	3 30
4 0	3 21	2 57	2 27	1 38	1 8	0 49	1 2	1 20	1 38	1 57	2 18	2 33	2 51	3 9	3 21	4 0
4 30	3 26	3 2	2 32	1 43	1 13	0 54	1 7	1 25	1 43	2 2	2 23	2 38	2 56	3 14	3 26	4 30
5 0	3 32	3 8	2 38	1 49	1 19	1 0	1 13	1 31	1 49	2 8	2 29	2 44	3 2	3 20	3 32	5 0
5 30	3 41	3 17	2 47	1 58	1 28	1 9	1 22	1 40	1 58	2 17	2 38	2 53	3 11	3 29	3 41	5 30
6 0	3 52	3 28	2 58	2 9	1 39	1 20	1 33	1 51	2 9	2 28	2 49	3 4	3 22	3 40	3 52	6 0
6 30	4 1	3 37	3 7	2 18	1 48	1 29	1 42	2 0	2 18	2 37	2 58	3 13	3 31	3 49	4 1	6 30
7 0	4 8	3 44	3 14	2 25	1 55	1 36	1 49	2 7	2 25	2 44	3 5	3 20	3 38	3 56	4 8	7 0
7 30	4 15	3 51	3 21	2 32	2 2	1 43	1 56	2 14	2 32	2 51	3 12	3 27	3 45	4 3	4 15	7 30
8 0	4 18	3 54	3 24	2 35	2 5	1 46	1 59	2 17	2 35	2 54	3 15	3 30	3 48	4 6	4 18	8 0
8 30	4 19	3 55	3 25	2 36	2 6	1 47	2 0	2 18	2 36	2 55	3 16	3 31	3 49	4 7	4 19	8 30
9 0	4 16	3 54	3 24	2 35	2 5	1 46	1 59	2 17	2 35	2 54	3 15	3 30	3 48	4 6	4 18	9 0
9 30	4 15	3 51	3 21	2 32	2 2	1 43	1 56	2 14	2 32	2 51	3 12	3 27	3 45	4 3	4 15	9 30
10 0	4 10	3 46	3 16	2 27	1 57	1 38	1 51	2 9	2 27	2 46	3 7	3 22	3 40	3 58	4 10	10 0
10 30	4 6	3 42	3 12	2 23	1 53	1 34	1 47	2 5	2 23	2 42	3 3	3 18	3 36	3 54	4 6	10 30
11 0	4 0	3 36	3 6	2 17	1 47	1 28	1 41	1 59	2 17	2 36	2 57	3 12	3 30	3 48	4 0	11 0
11 30	3 54	3 30	3 0	2 11	1 41	1 22	1 35	1 53	2 11	2 30	2 51	3 6	3 24	3 42	3 54	11 30

TABLE V.—PORT TOWNSHEND.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.															Time of moon's transit.
	Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
0 0	3 45	4 9	4 39	5 28	5 58	6 17	6 4	5 46	5 28	5 9	4 48	4 33	4 15	3 57	3 45	0 0
0 30	3 38	4 2	4 32	5 21	5 51	6 10	5 57	5 39	5 21	5 2	4 41	4 26	4 8	3 50	3 38	0 30
1 0	3 32	3 56	4 26	5 15	5 45	6 4	5 51	5 33	5 15	4 56	4 35	4 20	4 2	3 44	3 32	1 0
1 30	3 26	3 50	4 20	5 9	5 39	5 58	5 45	5 27	5 9	4 50	4 29	4 14	3 56	3 38	3 26	1 30
2 0	3 21	3 45	4 15	5 4	5 34	5 53	5 40	5 22	5 4	4 45	4 24	4 9	3 51	3 33	3 21	2 0
2 30	3 18	3 42	4 12	5 1	5 31	5 50	5 37	5 19	5 1	4 42	4 21	4 6	3 48	3 30	3 18	2 30
3 0	3 16	3 40	4 10	4 59	5 29	5 48	5 35	5 17	4 59	4 40	4 19	4 4	3 46	3 28	3 16	3 0
3 30	3 17	3 41	4 11	5 0	5 30	5 49	5 36	5 18	5 0	4 41	4 20	4 5	3 47	3 29	3 17	3 30
4 0	3 21	3 45	4 15	5 4	5 34	5 53	5 40	5 22	5 4	4 45	4 24	4 9	3 51	3 33	3 21	4 0
4 30	3 26	3 50	4 20	5 9	5 39	5 58	5 45	5 27	5 9	4 50	4 29	4 14	3 56	3 38	3 26	4 30
5 0	3 32	3 56	4 26	5 15	5 45	6 4	5 51	5 33	5 15	4 56	4 35	4 20	4 2	3 44	3 32	5 0
5 30	3 41	4 5	4 35	5 24	5 54	6 13	6 0	5 42	5 24	5 5	4 44	4 29	4 11	3 53	3 41	5 30
6 0	3 52	4 16	4 46	5 35	6 5	6 24	6 11	5 53	5 35	5 16	4 55	4 40	4 22	4 4	3 52	6 0
6 30	4 1	4 25	4 55	5 44	6 14	6 33	6 20	6 2	5 44	5 25	5 4	4 49	4 31	4 13	4 1	6 30
7 0	4 8	4 32	5 2	5 51	6 21	6 40	6 27	6 9	5 51	5 32	5 11	4 56	4 38	4 20	4 8	7 0
7 30	4 15	4 39	5 9	5 58	6 28	6 47	6 34	6 16	5 58	5 39	5 18	5 3	4 45	4 27	4 15	7 30
8 0	4 18	4 42	5 12	6 1	6 31	6 50	6 37	6 19	6 1	5 42	5 21	5 6	4 48	4 30	4 18	8 0
8 30	4 19	4 43	5 13	6 2	6 32	6 51	6 38	6 20	6 2	5 43	5 22	5 7	4 49	4 31	4 19	8 30
9 0	4 18	4 42	5 12	6 1	6 31	6 50	6 37	6 19	6 1	5 42	5 21	5 6	4 48	4 30	4 18	9 0
9 30	4 15	4 39	5 9	5 58	6 28	6 47	6 34	6 16	5 58	5 39	5 18	5 3	4 45	4 27	4 15	9 30
10 0	4 10	4 34	5 4	5 53	6 23	6 42	6 29	6 11	5 53	5 34	5 13	4 58	4 40	4 22	4 10	10 0
10 30	4 6	4 30	5 0	5 49	6 19	6 38	6 25	6 7	5 49	5 30	5 9	4 54	4 36	4 18	4 6	10 30
11 0	4 0	4 24	4 54	5 43	6 13	6 32	6 19	6 1	5 43	5 24	5 3	4 48	4 30	4 12	4 0	11 0
11 30	3 54	4 18	4 48	5 37	6 7	6 26	6 13	5 55	5 37	5 18	4 57	4 42	4 21	4 6	3 54	11 30

If we disregard the daily inequality, the column headed San Francisco in Table II would give us, as in the examples on the Atlantic coast, the means of determining the time of high water.

Example V.—Required the time of high water at North Beach, San Francisco, Cal., on the 7th February, 1853.

1st. The time of the moon's transit at Greenwich, from the Nautical Almanac, is 11*h.* 41*m.*; the longitude of San Francisco 8*h.* 10*m.*; requiring a correction of 16*m.* to the time of transit for San Francisco, which is thus found to be 11*h.* 57*m.*

2d. The moon's declination is south, and at the time of transit about two days after the greatest. Entering Table IV we find 12*h.* (or 0*h.*) of transit, the nearest number to 11*h.* 57*m.* which the table gives; and following the line horizontally until we come to two days after the greatest declination we find 13*h.* 14*m.*

To 11*h.* 57*m.*, time of transit of the moon, February 7, San Francisco,

Add 13 14 from column 0*h.* transit and two days after greatest declination.

The sum 25 11 or 1*h.* 11*m.*, February 8, is the time of high water corresponding to the transit which we took of February 7. If we desire the tide of February 7, we must go back to the moon's transit of the 6th. The example was purposely assumed to show this case:

11*h.* 1*m.*, time of transit February 6, 1853,

13 31 number for 11*h.* transit and one day from greatest declination.

Sum 24 32 time of high water 0*h.* 32*m.* a. m. February 7.

The height of high water.—The height of high water is obtained in a similar manner by the use of Table VI and Table VII, entering these in the same way with the time of transit and days from the greatest declination. Table VI is for south declination, and Table VII for north.

TABLE VI.—SAN DIEGO.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.															Time of moon's transit.
	Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	4.7	4.5	4.3	4.2	4.1	4.1	4.1	4.1	4.2	4.3	4.5	4.8	5.1	5.5	5.8	0
1	4.6	4.4	4.2	4.1	4.0	4.0	4.0	4.0	4.1	4.2	4.4	4.7	5.0	5.4	5.7	1
2	4.4	4.2	4.0	3.9	3.8	3.8	3.8	3 8	3.9	4.0	4.2	4.5	4.8	5.2	5.5	2
3	4.1	3.9	3.7	3.6	3.5	3.5	3.5	3.5	3.6	3.7	3.9	4.2	4.5	4.9	5.2	3
4	3.8	3.6	3.4	3.3	3.2	3.2	3.2	3.2	3.3	3.4	3 6	3.9	4.2	4.6	4.9	4
5	3.6	3.4	3.2	3.1	3.0	3.0	3 0	3.0	3.1	3.2	3.4	3.7	4.0	4.4	4.7	5
6	3.6	3.4	3.2	3.1	3.0	3.0	3.0	3.0	3.1	3.2	3.4	3.7	4.0	4.4	4.7	6
7	3.7	3.5	8.3	3.2	3.1	3.1	3.1	3.1	3.2	3.3	3.5	3.8	4.1	4.5	4.8	7
8	3.8	3.6	3.4	3.3	3 2	3.2	3.2	3.2	3.3	3.4	3.6	3.9	4.2	4.6	4.9	8
9	4.4	4.2	4.0	3.9	3.8	3.8	3.8	3.8	3.9	4.0	4.2	4.5	4.8	5.2	5.5	9
10	4.7	4.5	4.3	4.2	4.1	4.1	4.1	4.1	4.2	4.3	4.5	4.8	5.1	5.5	5.8	10
11	4.8	4.6	4.4	4.3	4.2	4.2	4.2	4.2	4.3	4.4	4.6	4.9	5.2	5.6	5.9	11

TABLE VII.—SAN DIEGO.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.															Time of moon's transit.
	Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	5.7	5.9	6.1	6.2	6.3	6.3	6.3	6.3	6.2	6.1	5.9	5.6	5.3	4.9	4.6	0
1	5.6	5.8	6.0	6.1	6.2	6.2	6.2	6.2	6.1	6.0	5.8	5.5	5.2	4.8	4.5	1
2	5.4	5.6	5.8	5.9	6.0	6.0	6.0	6.0	5.9	5.8	5.6	5.3	5.0	4.6	4.3	2
3	5.1	5.3	5.5	5.6	5.7	5.7	5.7	5.7	5.6	5.5	5.3	5.0	4.7	4.3	4.0	3
4	4.8	5.0	5.2	5.3	5.4	5.4	5.4	5.4	5.3	5.2	5.0	4.7	4.4	4.0	3.7	4
5	4.6	4.8	5.0	5.1	5.2	5.2	5.2	5.2	5.1	5.0	4.8	4.5	4.2	3.8	3.5	5
6	4.6	4.8	5.0	5.1	5.2	5.2	5.2	5.2	5.1	5.0	4.8	4.5	4.2	3.8	3.5	6
7	4.7	4.9	5.1	5.2	5.3	5.3	5.3	5.3	5.2	5.1	4.9	4.6	4.3	3.9	3.6	7
8	4.8	5.0	5.2	5.3	5.4	5.4	5.4	5.4	5.3	5.2	5.0	4.7	4.4	4.0	3.7	8
9	5.4	5.6	5.8	5.9	6.0	6.0	6.0	6.0	5.9	5.8	5.6	5.3	5.0	4.6	4.3	9
10	5.7	5.9	6.1	6.2	6.3	6.3	6.3	6.3	6.2	6.1	5.9	5.6	5.3	4.9	4.6	10
11	5.8	6.0	6.2	6.3	6.4	6.4	6.4	6.4	6.3	6.2	6.0	5.7	5.4	5.0	4.7	11

TABLE VI.—SAN FRANCISCO.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.															Time of moon's transit.
	Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	4.8	4.7	4.5	4.3	4.3	4.2	4.3	4.3	4.4	4.5	4.7	4.8	5.0	5.3	5.5	0
1	4.7	4.6	4.4	4.2	4.2	4.1	4.2	4.2	4.3	4.4	4.6	4.7	4.9	5.2	5.4	1
2	4.6	4.5	4.3	4.1	4.1	4.0	4.1	4.1	4.2	4.3	4.5	4.6	4.8	5.1	5.3	2
3	4.5	4.4	4.2	4.0	4.0	3.9	4.0	4.0	4.1	4.2	4.4	4.5	4.7	5.0	5.2	3
4	4.3	4.2	4.0	3.8	3.8	3.7	3.8	3.8	3.9	4.0	4.2	4.3	4.5	4.8	5.0	4
5	4.1	4.0	3.8	3.6	3.6	3.5	3.6	3.6	3.7	3.8	4.0	4.1	4.3	4.6	4.8	5
6	4.1	4.0	3.8	3.6	3.6	3.5	3.6	3.6	3.7	3.8	4.0	4.1	4.3	4.6	4.8	6
7	4.2	4.1	3.9	3.7	3.7	3.6	3.7	3.7	3.8	3.9	4.1	4.2	4.4	4.7	4.9	7
8	4.4	4.3	4.1	3.9	3.9	3.8	3.9	3.9	4.0	4.1	4.3	4.4	4.6	4.9	5.1	8
9	4.5	4.4	4.2	4.0	4.0	3.9	4.0	4.0	4.1	4.2	4.4	4.5	4.7	5.0	5.2	9
10	4.7	4.6	4.4	4.2	4.2	4.1	4.2	4.2	4.3	4.4	4.6	4.7	4.9	5.2	5.4	10
11	4.8	4.7	4.5	4.3	4.3	4.2	4.3	4.3	4.4	4.5	4.7	4.8	5.0	5.3	5.5	11

TABLE VII.—SAN FRANCISCO.

Time of moon's transit.	NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.															Time of moon's transit.
	Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	5.4	5.5	5.7	5.9	5.9	6.0	5.9	5.9	5.8	5.7	5.5	5.4	5.2	4.9	4.7	0
1	5.3	5.4	5.6	5.8	5.8	5.9	5.8	5.8	5.7	5.6	5.4	5.3	5.1	4.8	4.6	1
2	5.2	5.3	5.5	5.7	5.7	5.8	5.7	5.7	5.6	5.5	5.3	5.2	5.0	4.7	4.5	2
3	5.1	5.2	5.4	5.6	5.6	5.7	5.6	5.6	5.5	5.4	5.2	5.1	4.9	4.6	4.4	3
4	4.9	5.0	5.2	5.4	5.4	5.5	5.4	5.4	5.3	5.2	5.0	4.9	4.7	4.4	4.2	4
5	4.7	4.8	5.0	5.2	5.2	5.3	5.2	5.2	5.1	5.0	4.8	4.7	4.5	4.2	4.0	5
6	4.7	4.8	5.0	5.2	5.2	5.3	5.2	5.2	5.1	5.0	4.8	4.7	4.5	4.2	4.0	6
7	4.8	4.9	5.1	5.3	5.3	5.4	5.3	5.3	5.2	5.1	4.9	4.8	4.6	4.3	4.1	7
8	5.0	5.1	5.3	5.5	5.5	5.6	5.5	5.5	5.4	5.3	5.1	5.0	4.8	4.5	4.3	8
9	5.1	5.2	5.4	5.6	5.6	5.7	5.6	5.6	5.5	5.4	5.2	5.1	4.9	4.6	4.4	9
10	5.3	5.4	5.6	5.8	5.8	5.9	5.8	5.8	5.7	5.6	5.4	5.3	5.1	4.8	4.6	10
11	5.4	5.5	5.7	5.9	5.9	6.0	5.9	5.9	5.8	5.7	5.5	5.4	5.2	4.9	4.7	11

TABLE VI.—ASTORIA.

SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.

Time of moon's transit.	Before— 7	Before— 6	Before— 5	Before— 4	Before— 3	Before— 2	Before— 1	0	After— 1	After— 2	After— 3	After— 4	After— 5	After— 6	After— 7	Time of moon's transit.
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	8.0	8.3	8.4	8.5	8.6	8.6	8.6	8.6	8.5	8.4	8.3	8.1	7.7	7.4	7.0	0
1	8.0	8.2	8.4	8.5	8.6	8.6	8.6	8.5	8.5	8.4	8.2	8.1	7.7	7.4	7.0	1
2	7.8	8.1	8.2	8.4	8.4	8.4	8.4	8.6	8.3	8.2	8.1	7.9	7.5	7.2	6.8	2
3	7.5	7.8	7.9	8.1	8.1	8.1	8.1	8.1	8.0	7.9	7.8	7.6	7.2	6.9	6.5	3
4	7.1	7.6	7 5	7.7	7.7	7.7	7.7	7.7	7.6	7.5	7.4	7.2	6.8	6.5	6.1	4
5	6.7	7.0	7.2	7.3	7.3	7.3	7.3	7.3	7.2	7.1	7.0	6.8	6.5	6.1	5.7	5
6	6.5	6.8	7.0	7.1	7.1	7.1	7.1	7.1	7.0	6.9	6.8	6.6	6.3	5.9	5.5	6
7	6.7	7.0	7.1	7.2	7.3	7.3	7.3	7.3	7.2	7.1	7.0	6.8	6.4	6.1	5.7	7
8	7.0	7.3	7.5	7.6	7 6	7.6	7.6	7.6	7.5	7.4	7.3	7.1	6.8	6.4	6 0	8
9	7.5	7.8	8.0	8.1	8.1	8.1	8.1	8.1	8.0	7.9	7.8	7.6	7.3	6.9	6.5	9
10	7.9	8.2	8.4	8.5	8.5	8.5	8.5	8.5	8.4	8.3	8.2	8.0	7.7	7.3	6.9	10
11	8.1	8.4	8.6	8.7	8.7	8.7	8.7	8.7	8.6	8.5	8.4	8.2	7.9	7.5	7.1	11

TABLE VII.—ASTORIA.

NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.

Time of moon's transit.	Before— 7	Before— 6	Before— 5	Before— 4	Before— 3	Before— 2	Before— 1	0	After— 1	After— 2	After— 3	After— 4	After— 5	After— 6	After— 7	Time of moon's transit.
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	7.4	7.1	6.9	6.8	6.8	6.8	6 8	6.8	6.9	7.0	7.1	7.3	7.6	8.0	8.4	0
1	7.4	7.1	6.9	6.8	6.8	6.8	6.8	6.8	6.9	7.0	7.1	7.3	7.6	8.0	8.4	1
2	7 2	6 9	6.8	6.6	6.6	6.6	6.6	6.6	6.7	6.8	6.9	7.1	7.5	7.8	8.2	2
3	6.9	6.6	6 5	6.3	6.3	6.3	6.3	6.3	6.4	6.5	6.6	6.8	7.2	7.5	7.9	3
4	6.5	6.2	6.1	5.9	5.9	5.9	5.9	5.9	6.0	6.1	6.2	6.4	6 7	7.1	7.5	4
5	6.1	5.9	5.7	5.6	5.5	5.5	5.6	5.6	5.7	5 7	5.9	6.0	6.4	6.7	7.1	5
6	5.9	5.7	5.5	5.4	5.3	5.3	5.3	5.4	5.5	5.5	5.7	5.9	6.2	6.5	6.9	6
7	6.1	5.8	5.6	5.5	5.5	5.5	5.5	5.5	5 6	5.7	5.8	6.0	6.3	6.7	7.1	7
8	6.4	6.2	6 0	5 9	5.8	5.8	5.8	5.8	5.9	6.0	6.2	6.3	6.7	7.0	7.4	8
9	6.9	6.7	6.5	6.4	6.3	6.3	6.3	6.4	6.4	6.5	6.7	6.8	7.2	7.5	7.9	9
10	7.3	7.1	6.9	6.8	6.7	6.7	6.7	6.8	6.9	6.9	7.0	7.2	7.6	7.9	8.3	10
11	7.5	7.2	7.1	7.0	6.9	6.9	6.9	6.9	7.0	7.1	7.2	7.4	7.8	8.1	8.5	11

TABLE VI.—PORT TOWNSHEND.

NORTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.

Time of moon's transit.	Before— 7	Before— 6	Before— 5	Before— 4	Before— 3	Before— 2	Before— 1	0	After— 1	After— 2	After— 3	After— 4	After— 5	After— 6	After— 7	Time of moon's transit.
Hour.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Hour.*
0	6.6	6.3	5.9	6.1	6.4	6.9	7.2	7.4	7.5	7.5	7.5	7.5	7.6	7.7	7.9	0
1	6.7	6.4	6.0	6.2	6.5	7.0	7.3	7.5	7.6	7.6	7.6	7.6	7.7	7.8	8.0	1
2	6.6	6.3	5.9	6.1	6.4	6.9	7.2	7.4	7.5	7.5	7.5	7.5	7.6	7.7	7.9	2
3	6 3	6.0	5.6	5.8	6.1	6.6	6.9	7.1	7.2	7.2	7.2	7.4	7.3	7.4	7.6	3
4	6.0	5.7	5.3	5.5	5.8	6.3	6.6	6.8	6.9	6.9	6.9	6.9	7 0	7.1	7.3	4
5	5.9	5.6	5.2	5.4	5.7	6.2	6.5	6.7	6.8	6.8	6.8	6.8	6.9	7.0	7.2	5
6	6.1	5.8	5.4	5.6	5.9	6.4	6.7	6.9	7.0	7.0	7.0	7.0	7.1	7 2	7.4	6
7	6.4	6.1	5.7	5.9	6.2	6.7	7.0	7.2	7.3	7.3	7.3	7.3	7.4	7.5	7.7	7
8	6.5	6.2	5.8	6.0	6.3	6.8	7.1	7.3	7.4	7.4	7.4	7.4	7.5	7.6	7.8	8
9	6.5	6.2	5.8	6.0	6.3	6.8	7.1	7.3	7.4	7.4	7.4	7.4	7.5	7.6	7.8	9
10	6.6	6.3	5.9	6.1	6.4	6.9	7.2	7.4	7.5	7.5	7.5	7.5	7.6	7.7	7.9	10
11	6.6	6.3	5.9	6.1	6.4	6.9	7.2	7.4	7.5	7.5	7.5	7.5	7.6	7.7	7.9	11

TABLE VII.—PORT TOWNSHEND.

Time of moon's transit.	SOUTH DECLINATION.—DAYS FROM MOON'S GREATEST DECLINATION.															Time of moon's transit.
	Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
Hour.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Hour.
0	7.6	7.9	8.3	8.1	7.8	7.3	7.0	6.8	6.7	6.7	6.7	6.7	6.6	6.5	6.3	0
1	7.7	8.0	8.4	8.2	7.9	7.4	7.1	6.9	6.8	6.8	6.8	6.8	6.7	6.6	6.4	1
2	7.6	7.9	8.3	8.1	7.8	7.3	7.0	6.8	6.7	6.7	6.7	6.7	6.6	6.5	6.3	2
3	7.3	7.6	8.0	7.8	7.5	7.0	6.7	6.5	6.4	6.4	6.4	6.4	6.3	6.2	6.0	3
4	7.0	7.3	7.7	7.5	7.2	6.7	6.4	6.2	6.1	6.1	6.1	6.1	6.0	5.9	5.7	4
5	6.9	7.2	7.6	7.4	7.1	6.6	6.3	6.1	6.0	6.0	6.0	6.0	5.9	5.8	5.6	5
6	7.1	7.4	7.8	7.6	7.3	6.8	6.5	6.3	6.2	6.2	6.2	6.2	6.1	6.0	5.8	6
7	7.4	7.7	8.1	7.9	7.6	7.1	6.8	6.6	6.5	6.5	6.5	6.5	6.4	6.3	6.1	7
8	7.5	7.8	8.2	8.0	7.7	7.2	6.9	6.7	6.6	6.6	6.6	6.6	6.5	6.4	6.2	8
9	7.5	7.8	8.2	8.0	7.7	7.2	6.9	6.7	6.6	6.6	6.6	6.6	6.5	6.4	6.2	9
10	7.6	7.9	8.3	8.1	7.8	7.3	7.0	6.8	6.7	6.7	6.7	6.7	6.6	6.5	6.3	10
11	7.6	7.9	8.3	8.1	7.8	7.3	7.0	6.8	6.7	6.7	6.7	6.7	6.6	6.5	6.3	11

NOTE.—To use these tables with a chart on which the soundings are referred to mean low water, substract 1.2 foot from the numbers in the tables from San Diego to Astoria, 1.7 foot for Neé-ah harbor, 2.3 for Port Townshend, and 2.7 for Semiahmoo and Steilacoom.

Example VI.—In Example V, to obtain the height of tide on February 7, the declination being south, we enter Table VI, for San Francisco, with 0*h.* of transit, and two days after greatest declination, and find that the tide will be 4.5 feet above the mean of the lowest low water, or that 4.5 feet are to be added to the soundings of a chart reduced to the mean of the lowest low waters of each day. If the soundings of the chart were given for mean low water, then 1.2 feet ought to be subtracted from the Tables VI and VII; thus, in this example, it would be 3.3 feet.

The approximate time of the successive low and high waters of the day will be found by adding the numbers in Table VIII to the time of the first high water already determined. The table gives the numbers for the different days from the greatest declination.

Tables containing numbers to be added to the time of high water found from Tables IV *and* V, *to obtain the successive low and high waters.*

TABLE VIII.—SAN DIEGO.

Days from moon's greatest declination.		SOUTH DECLINATION.			NORTH DECLINATION.			Days from moon's greatest declination.	
		Low water. (Small.)	High water. (Large.)	Low water. (Large.)	Low water. (Large.)	High water. (Small.)	Low water. (Small.)		
		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		
Before.	7	5 44	12 28	18 44	6 16	12 16	18 00	7	Before.
	6	5 18	11 58	18 40	6 42	12 46	18 04	6	
	5	5 00	11 34	18 34	7 00	13 10	18 10	5	
	4	4 47	11 12	18 25	7 13	13 32	18 19	4	
	3	4 34	10 54	18 20	7 26	13 50	18 24	3	
	2	4 24	10 38	18 14	7 36	14 06	18 30	2	
	1	4 17	10 28	18 11	7 43	14 16	18 33	1	
	0	4 12	10 20	18 08	7 48	14 24	18 36	0	
After.	1	4 14	10 20	18 06	7 46	14 24	18 38	1	After.
	2	4 24	10 28	18 04	7 36	14 16	18 40	2	
	3	4 38	10 40	18 02	7 22	14 04	18 42	3	
	4	5 01	10 58	17 57	6 59	13 46	18 47	4	
	5	5 25	11 18	17 53	6 35	13 26	18 51	5	
	6	5 49	11 44	17 55	6 11	13 00	18 49	6	
	7	6 18	12 18	18 00	5 42	12 26	18 44	7	

TABLE VIII.—SAN FRANCISCO.

	Days from moon's greatest declination.	South declination. Low water. (Small.)	South declination. High water. (Large.)	South declination. Low water. (Large.)	North declination. Low water. (Large)	North declination. High water. (Small.)	North declination. Low water. (Small.)	Days from moon's greatest declination.	
		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		
Before.	7	5 58	13 14	18 58	5 44	11 46	17 44	7	Before.
	6	5 36	12 42	18 48	6 06	12 18	17 54	6	
	5	5 14	12 10	18 38	6 26	12 50	18 04	5	
	4	4 55	11 34	18 21	6 47	13 26	18 21	4	
	3	4 37	11 00	18 05	7 05	14 00	18 37	3	
	2	4 24	10 34	17 52	7 18	14 26	18 50	2	
	1	4 12	10 06	17 36	7 30	14 54	19 06	1	
	0	4 12	10 00	17 30	7 30	15 00	19 12	0	
After.	1	4 17	10 02	17 27	7 25	14 56	19 15	1	After.
	2	4 27	10 12	17 27	7 15	14 48	19 15	2	
	3	4 41	10 26	17 27	7 01	14 34	19 15	3	
	4	4 56	10 46	17 32	6 46	14 14	19 10	4	
	5	5 14	11 10	17 38	6 26	13 50	19 04	5	
	6	5 36	11 36	17 42	6 06	13 24	19 00	6	
	7	5 57	12 04	17 49	5 45	12 56	18 53	7	

TABLE VIII.—ASTORIA.

	Days from moon's greatest declination.	South declination. Low water. (Small.)	South declination. High water. (Large.)	South declination. Low water. (Large.)	North declination. Low water. (Large.)	North declination. High water. (Small.)	North declination. Low water. (Small.)	Days from moon's greatest declination.	
		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		
Before.	7	6 38	12 59	19 17	6 18	12 03	18 41	7	Before.
	6	6 14	12 33	19 15	6 42	12 29	18 43	6	
	5	5 55	12 13	19 14	7 01	12 49	18 44	5	
	4	5 34	11 47	19 09	7 22	13 15	18 49	4	
	3	5 20	11 27	19 03	7 36	13 35	18 55	3	
	2	5 09	11 07	18 54	7 47	13 55	19 04	2	
	1	5 05	11 01	18 52	7 51	14 01	19 06	1	
	0	5 03	10 53	18 46	7 53	14 09	19 12	0	
After.	1	5 05	10 51	18 42	7 51	14 11	19 16	1	After.
	2	5 11	10 55	18 40	7 45	14 07	19 18	2	
	3	5 18	11 03	18 41	7 38	13 59	19 17	3	
	4	5 32	11 15	18 39	7 24	13 47	19 19	4	
	5	5 50	11 35	18 41	7 06	13 27	19 17	5	
	6	6 11	11 55	18 40	6 45	13 07	19 18	6	
	7	6 35	12 19	18 40	6 21	12 43	19 18	7	

TABLE VIII.—PORT TOWNSHEND.

	Days from moon's greatest declination.	South declination. Low water.	South declination. High water.	South declination. Low water.	North declination. Low water.	North declination. High water.	North declination. Low water.	Days from moon's greatest declination.	
		h. m.	h. m.	h. m.	h. m.	h. m.	h. m.		
Before.	7	5 05	12 26	18 05	5 39	12 26	18 31	7	Before.
	6	6 38	13 14	18 20	5 06	11 38	18 16	6	
	5	7 18	14 14	18 40	4 26	10 38	17 56	5	
	4	8 13	15 52	19 23	3 31	9 00	17 13	4	
	3	8 36	16 52	20 00	3 08	8 00	16 36	3	
	2	8 43	17 30	20 31	3 01	7 22	16 05	2	
	1	8 12	17 04	20 36	3 32	7 48	16 00	1	
	0	7 40	16 28	20 32	4 04	8 24	16 04	0	
After.	1	7 18	15 52	20 18	4 26	9 00	16 18	1	After.
	2	6 59	15 14	19 59	4 45	9 38	16 37	2	
	3	6 38	14 32	19 38	5 06	10 20	16 58	3	
	4	6 24	14 02	19 22	5 20	10 50	17 14	4	
	5	6 10	13 26	19 00	5 34	11 26	17 36	5	
	6	5 59	12 50	18 35	5 45	12 02	18 01	6	
	7	5 42	12 26	18 28	6 02	12 26	18 08	7	

The days from the greatest declination are written in the first and last columns of the table. The second, third, and fourth columns refer to south declination, and the fifth, sixth, and seventh to north. The second column gives the number which is to be added, according to the declination, to the time of high water, obtained by means of Tables IV and V, to give the next low water, which is the small low water *b* of Diagram I. The third contains the numbers to be added to the same to give the second or large high water *c* of Diagram I. The fourth, the numbers to be added to the same to give the second or large low water *d* of Diagram I. The succeeding columns give the numbers to be used in the same way for north declination, to obtain the low water *b* (large) of Diagram II; the high water *c* (small) and the low water *d* (small) of the same diagram. The rise and fall of the same successive tides may be obtained by inspection from Table IX, in which the first column at the side contains the time of transit, and the successive columns the numbers corresponding to that time and to the number of days from greatest declination. The arrangement of this table is like that already given.

The numbers for the small ebb tide *a b* of Diagram I, or *c d* of Diagram II, are first given; then those for small low and large high waters *b c* of Diagram I, and *d e* of Diagram II; next, the large ebb tide *c d* of Diagram I, or *a b* of Diagram II; and, lastly, from the large low water to the small high water *d e* of Diagram I, or *b c* of Diagram II.

TABLE IX.—SAN DIEGO.

SMALL EBB TIDE, OR FROM SMALL HIGH WATER TO SMALL LOW WATER.

Days from moon's greatest declination.

Hours of moon's transit.	Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7
	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
0	4.0	3.4	3.0	2.6	2.3	2.1	2.0	2.0	2.1	2.3	2.7	3.2	3.8	4.6	5.2
1	3.8	3.2	2.8	2.4	2.1	1.9	1.8	1.8	1.9	2.1	2.5	3.0	3.6	4.4	5.0
2	3.5	2.9	2.5	2.1	1.8	1.6	1.5	1.5	1.6	1.8	2.2	2.7	3.3	4.1	4.7
3	3.0	2.4	2.0	1.6	1.3	1.1	1.0	1.0	1.1	1.3	1.7	2.2	2.8	3.6	4.2
4	2.2	1.6	1.2	0.8	0.5	0.3	0.2	0.2	0.3	0.5	0.9	1.4	2.0	2.8	3.4
5	1.7	1.1	0.7	0.3	0.0	–.2	–.3	–.3	–.2	0.0	0.4	0.9	1.5	2.3	2.9
6	1.8	1.2	0.8	0.4	0.1	–.1	–.2	–.2	–.1	0.1	0.5	1.0	1.6	2.4	3.0
7	2.3	1.7	1.3	0.9	0.6	0.4	0.3	0.3	0.4	0.6	1.0	1.5	2.1	2.9	3.5
8	2.9	2.3	1.9	1.5	1.2	1.0	0.9	0.9	1.0	1.2	1.6	2.1	2.7	3.5	4.1
9	3.7	3.1	2.7	2.3	2.0	1.8	1.7	1.7	1.8	2.0	2.4	2.9	3.5	4.3	4.9
10	4.2	3.6	3.2	2.8	2.5	2.3	2.2	2.2	2.3	2.5	2.9	3.4	4.0	4.8	5.4
11	4.3	3.7	3.3	2.9	2.6	2.4	2.3	2.3	2.4	2.6	3.0	3.5	4.1	4.9	5.5

From *a* to *b*.................................... Diagram I.
From *c* to *d*.................................... Diagram II.

FROM SMALL LOW WATER TO LARGE HIGH WATER.

Days from moon's greatest declination.

Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7	Hours of moon's transit.
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	
5.1	4.9	4.7	4.5	4.4	4.3	4.2	4.2	4.1	4.1	4.0	4.0	3.9	3.9	4.0	0
4.9	4.7	4.5	4.3	4.2	4.1	4.0	4.0	3.9	3.9	3.8	3.8	3.7	3.7	3.8	1
4.6	4.4	4.2	4.0	3.9	3.8	3.7	3.7	3.6	3.6	3.5	3.5	3.4	3.4	3.5	2
4.1	3.9	3.7	3.5	3.4	3.3	3.2	3.2	3.1	3.1	3.0	3.0	2.9	2.9	3.0	3
3.3	3.1	2.9	2.7	2.6	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.1	2.1	2.2	4
2.8	2.6	2.4	2.2	2.1	2.0	1.9	1.9	1.8	1.8	1.7	1.7	1.6	1.6	1.7	5
2.9	2.7	2.5	2.3	2.2	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.7	1.7	1.8	6
3.4	3.2	3.0	2.8	2.7	2.6	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.2	2.3	7
4.0	3.8	3.6	3.4	3.3	3.2	3.1	3.1	3.0	3.0	2.9	2.9	2.8	2.8	2.9	8
4.8	4.6	4.4	4.2	4.1	4.0	3.9	3.9	3.8	3.8	3.7	3.7	3.6	3.6	3.7	9
5.3	5.1	4.9	4.7	4.6	4.5	4.4	4.4	4.3	4.3	4.2	4.2	4.1	4.1	4.2	10
5.4	5.2	5.0	4.8	4.7	4.6	4.5	4.5	4.4	4.4	4.3	4.3	4.2	4.2	4.3	11

From *b* to *c*.................................... Diagram I.
From *d* to *e*.................................... Diagram II.

TABLE IX.—SAN DIEGO—Continued.

LARGE EBB TIDE, OR FROM LARGE HIGH WATER TO LARGE LOW WATER.

Days from moon's greatest declination.

Hours of moon's transit.	Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7
	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
0	5.2	5.8	6.2	6.6	6.9	7.1	7.2	7.2	7.1	6.9	6.5	6.0	5.4	4.6	4.0
1	5.0	5.6	6.0	6.4	6.7	6.9	7.0	7.0	6.9	6.7	6.3	5.8	5.2	4.4	3.8
2	4.7	5.3	5.7	6.1	6.4	6.6	6.7	6.7	6.6	6.4	6.0	5.5	4.9	4.1	3.5
3	4.2	4.8	5.2	5.6	5.9	6.1	6.2	6.2	6.1	5.9	5.5	5.0	4.4	3.6	3.0
4	3.4	4.0	4.4	4.8	5.1	5.3	5.4	5.4	5.3	5.1	4.7	4.2	3.6	2.8	2.2
5	2.9	3.5	3.9	4.3	4.6	4.8	4.9	4.9	4.8	4.6	4.2	3.7	3.1	2.3	1.7
6	3.0	3.6	4.0	4.4	4.7	4.9	5.0	5.0	4.9	4.7	4.3	3.8	3.2	2.4	1.8
7	3.5	4.1	4.5	4.9	5.2	5.4	5.5	5.5	5.4	5.2	4.8	4.3	3.7	2.9	2.3
8	4.1	4.7	5.1	5.5	5.8	6.0	6.1	6.1	6.0	5.8	5.4	4.9	4.3	3.5	2.9
9	4.9	5.5	5.9	6.3	6.6	6.8	6.9	6.9	6.8	6.6	6.2	5.7	5.1	4.3	3.7
10	5.4	6.0	6.4	6.8	7.1	7.3	7.4	7.4	7.3	7.1	6.7	6.2	5.6	4.8	4.2
11	5.5	6.1	6.5	6.9	7.2	7.4	7.5	7.5	7.4	7.2	6.8	6.3	5.7	4.9	4.3

From *c* to *d*.................................... Diagram I.
From *a* to *b*.................................... Diagram II.

FROM LARGE LOW WATER TO SMALL HIGH WATER.

Days from moon's greatest declination.

Before— 7	6	5	4	3	2	1	0	After— 1	2	3	4	5	6	7	Hours of moon's transit.
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	
4.1	4.3	4.5	4.7	4.8	4.9	5.0	5.0	5.1	5.1	5.2	5.2	5.3	5.3	5.2	0
3.9	4.1	4.3	4.5	4.6	4.7	4.8	4.8	4.9	4.9	5.0	5.0	5.1	5.1	5.0	1
3.6	3.8	4.0	4.2	4.3	4.4	4.5	4.5	4.6	4.6	4.7	4.7	4.8	4.8	4.7	2
3.1	3.3	3.5	3.7	3.8	3.9	4.0	4.0	4.1	4.1	4.2	4.2	4.3	4.3	4.2	3
2.3	2.5	2.7	2.9	3.0	3.1	3.2	3.2	3.3	3.3	3.4	3.4	3.5	3.5	3.4	4
1.8	2.0	2.3	2.4	2.5	2.6	2.7	2.7	2.8	2.8	2.9	2.9	3.0	3.0	2.9	5
1.9	2.1	2.3	2.5	2.6	2.7	2.8	2.8	2.9	2.9	3.0	3.0	3.1	3.1	3.0	6
2.4	2.6	2.8	3.0	3.1	3.2	3.3	3.3	3.4	3.4	3.5	3.5	3.6	3.6	3.5	7
3.0	3.2	3.4	3.6	3.7	3.8	3.9	3.9	4.0	4.0	4.1	4.1	4.2	4.2	4.1	8
3.8	4.0	4.2	4.4	4.5	4.6	4.7	4.7	4.8	4.8	4.9	4.9	5.0	5.0	4.9	9
4.3	4.5	4.7	4.9	5.0	5.1	5.2	5.2	5.3	5.3	5.4	5.4	5.5	5.5	5.4	10
4.4	4.6	4.8	5.0	5.1	5.2	5.3	5.3	5.4	5.4	5.5	5.5	5.6	5.6	5.5	11

From *d* to *e*.................................... Diagram I.
From *b* to *c*.................................... Diagram II.

TABLE IX.—SAN FRANCISCO.

Hours of moon's transit.	SMALL EBB TIDE, OR FROM SMALL HIGH WATER TO SMALL LOW WATER															FROM SMALL LOW WATER TO LARGE HIGH WATER.															Hours of moon's transit.
	Days from moon's greatest declination.															Days from moon's greatest declination.															
	Before—								After—							Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
	Ft.	Ft.	Ft.	Ft.	Ft.	Ft	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft	Ft.	
0	4.7	4.0	3.4	2.9	2.4	2.0	1.8	1.7	1.7	1.9	2.2	2.6	3.1	3.7	4.4	5.2	4.9	4.6	4.5	4.0	3.7	3.4	3.2	3.1	3.0	3.1	3.1	3.3	3.4	3.5	0
1	4.5	3.8	3.2	2.7	2.2	1.8	1.6	1.5	1.5	1.7	2.0	2.4	2.9	3.5	4.2	5.0	4.7	4.4	4.3	3.8	3.5	3.2	3.0	2.9	2.8	2.9	2.9	3.1	3.2	3.3	1
2	4.3	3.6	3.0	2.5	2.0	1.6	1.4	1.3	1.3	1.5	1.8	2.2	2.7	3.3	4.0	4.8	4.5	4.2	4.1	3.6	3.3	3.0	2.8	2.7	2.6	2.7	2.7	2.9	3.0	3.1	2
3	4.0	3.3	2.7	2.2	1.7	1.3	1.1	1.0	1.0	1.2	1.5	1.9	2.4	3.0	3.7	4.5	4.2	3.9	3.8	3.3	3.0	2.7	2.5	2.4	2.3	2.4	2.4	2.6	2.7	2.8	3
4	3.6	2.9	2.3	1.8	1.3	0.9	0.7	0.6	0.6	0.8	1.1	1.5	2.0	2.6	3.3	4.1	3.8	3.5	3.4	2.9	2.6	2.3	2.1	2.0	1.9	2.0	2.0	2.2	2.3	2.4	4
5	3.2	2.5	1.9	1.4	0.9	0.5	0.3	0.2	0.2	0.4	0.7	1.1	1.6	2.2	2.9	3.7	3.4	3.1	3.0	2.5	2.2	1.9	1.7	1.6	1.5	1.6	1.6	1.8	1.9	2.0	5
6	3.2	2.5	1.9	1.4	0.9	0.5	0.3	0.2	0.2	0.4	0.7	1.1	1.6	2.2	2.9	3.7	3.4	3.1	3.0	2.5	2.2	1.9	1.7	1.6	1.5	1.6	1.6	1.8	1.9	2.0	6
7	3.4	2.7	2.1	1.6	1.1	0.7	0.5	0.4	0.4	0.6	0.9	1.3	1.8	2.4	3.1	3.9	3.6	3.3	3.2	2.7	2.4	2.1	1.9	1.8	1.7	1.8	1.8	2.0	2.1	2.2	7
8	3.8	3.1	2.5	2.0	1.5	1.1	0.9	0.8	0.8	1.0	1.3	1.7	2.2	2.8	3.5	4.3	4.0	3.7	3.6	3.1	2.8	2.5	2.3	2.2	2.1	2.2	2.2	2.4	2.5	2.6	8
9	4.1	3.4	2.8	2.3	1.8	1.4	1.2	1.1	1.1	1.3	1.6	2.0	2.5	3.1	3.8	4.6	4.3	4.0	3.9	3.4	3.1	2.8	2.6	2.5	2.4	2.5	2.5	2.7	2.8	2.9	9
10	4.5	3.8	3.2	2.7	2.2	1.8	1.6	1.5	1.5	1.7	2.0	2.4	2.9	3.5	4.2	5.0	4.7	4.4	4.3	3.8	3.5	3.2	3.0	2.9	2.8	2.9	2.9	3.1	3.2	3.3	10
11	4.7	4.0	3.4	2.9	2.4	2.0	1.8	1.7	1.7	1.9	2.2	2.6	3.1	3.7	4.4	5.2	4.9	4.6	4.5	4.0	3.7	3.4	3.2	3.1	3.0	3.1	3.1	3.3	3.4	3.5	11

From *a* to *b*.................................... ......Diagram I.
From *c* to *d*..Diagram II.

From *b* to *c*................. ....Diagram I.
From *d* to *e* ....Diagram II.

TABLE IX.—SAN FRANCISCO—Continued.

Hours of moon's transit.	LARGE EBB TIDE, OR FROM LARGE HIGH WATER TO LARGE LOW WATER.															FROM LARGE LOW WATER TO SMALL HIGH WATER.															Hours of moon's transit.
	Days from moon's greatest declination.															Days from moon's greatest declination.															
	Before—								After—							Before—								After -							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
	Ft.	Ft.	Ft.	Ft.	Ft	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	
0	3.9	4.6	5.2	5.7	6.2	6.6	6.8	6.9	6.9	6.7	6.4	6.0	5.5	4.9	4.2	3.4	3.7	4.0	4.1	4.6	4.9	5.2	5.4	5.5	5.6	5.6	5.5	5.3	5.2	5.2	0
1	3.7	4.4	5.0	5.5	6.0	6.4	6.6	6.7	6.7	6.5	6.2	5.8	5.3	4.7	4.0	3.2	3.5	3.8	3.9	4.4	4.7	5.0	5.2	5.3	5.4	5.3	5.3	5.1	5.0	5.0	1
2	3.5	4.2	4.8	5.3	5.8	6.2	6.4	6.5	6.5	6.3	6.0	5.6	5.1	4.5	3.8	3.0	3.3	3.6	3.7	4.2	4.5	4.8	5.0	5.1	5.2	5.1	5.1	4.9	4.8	4.8	2
3	3.2	3.9	4.5	5.0	5.5	5.9	6.1	6.2	6.2	6.0	5.7	5.3	4.8	4.2	3.5	2.7	3.0	3.3	3.4	3.9	4.2	4.5	4.7	4.8	4.9	4.8	4.8	4.6	4.5	4.5	3
4	2.8	3.5	4.1	4.6	5.1	5.5	5.7	5.8	5.8	5.6	5.3	4.9	4.4	3.8	3.1	2.3	2.6	2.9	3.0	3.5	3.8	4.1	4.3	4.4	4.5	4.4	4.4	4.2	4.1	4.1	4
5	2.4	3.1	3.7	4.2	4.7	5.1	5.3	5.4	5.4	5.2	4.9	4.5	4.0	3.4	2.7	1.9	2.2	2.5	2.6	3.1	3.4	3.7	3.9	4.0	4.1	4.0	4.0	3.8	3.7	3.7	5
6	2.4	3.1	3.7	4.2	4.7	5.1	5.3	5.4	5.4	5.2	4.9	4.5	4.0	3.4	2.7	1.9	2.2	2.5	2.6	3.1	3.4	3.7	3.9	4.0	4.1	4.0	4.0	3.8	3.7	3.7	6
7	2.6	3.3	3.9	4.4	4.9	5.3	5.5	5.6	5.6	5.4	5.1	4.7	4.2	3.6	2.9	2.1	2.4	2.7	2.8	3.3	3.6	3.9	4.1	4.2	4.3	4.2	4.2	4.0	3.9	3.9	7
8	3.0	3.7	4.3	4.8	5.3	5.7	5.9	6.0	6.0	5.8	5.5	5.1	4.6	4.0	3.3	2.5	2.8	3.1	3.2	3.7	4.0	4.3	4.5	4.6	4.7	4.6	4.6	4.4	4.3	4.3	8
9	3.3	4.0	4.6	5.1	5.6	6.0	6.2	6.3	6.3	6.1	5.8	5.4	4.9	4.3	3.6	2.8	3.1	3.4	3.5	4.0	4.3	4.6	4.8	4.9	5.0	4.9	4.9	4.7	4.6	4.6	9
10	3.7	4.4	5.0	5.5	6.0	6.4	6.6	6.7	6.7	6.5	6.2	5.8	5.3	4.7	4.0	3.2	3.5	3.8	3.9	4.4	4.7	5.0	5.2	5.3	5.4	5.3	5.3	5.1	5.0	5.0	10
11	3.9	4.6	5.2	5.7	6.2	6.6	6.8	6.9	6.9	6.7	6.4	6.0	5.5	4.9	4.2	3.4	3.7	4.0	4.1	4.6	4.9	5.2	5.4	5.5	5.6	5.5	5.5	5.3	5.2	5.2	11

From *c* to *d*.................................... ....Diagram I.
From *a* to *b*............................ ... .Diagram II.

From *d* to *e*...Diagram I.
From *b* to *c*....... ....Diagram II.

TABLE IX.—ASTORIA.

SMALL EBB TIDE, OR FROM SMALL HIGH WATER TO SMALL LOW WATER

Days from moon's greatest declination.

Hours of moon's transit.	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
0	7.4	6.7	6.0	5.4	5.0	4.6	4.5	4.5	4.6	4.7	5.1	5.5	6.2	6.9	7.8
1	7.5	6.8	6.1	5.5	5.1	4.7	4.6	4.6	4.7	4.8	5.2	5.6	6.3	7.0	7.9
2	7.2	6.5	5.8	5.2	4.8	4.4	4.3	4.3	4.4	4.5	4.9	5.3	6.0	6.7	7.6
3	6.6	5.9	5.2	4.6	4.2	3.8	3.7	3.7	3.8	3.9	4.3	4.7	5.4	6.1	7.0
4	5.9	5.2	4.5	3.9	3.5	3.1	3.0	3.0	3.1	3.2	3.6	4.0	4.7	5.4	6.3
5	5.2	4.5	3.8	3.2	2.8	2.4	2.3	2.3	2.4	2.5	2.9	3.3	4.0	4.7	5.6
6	4.8	4.1	3.4	2.8	2.4	2.0	1.9	1.9	2.0	2.1	2.5	2.9	3.6	4.3	5.2
7	5.0	4.3	3.6	3.0	2.6	2.2	2.1	2.1	2.2	2.3	2.7	2.1	3.8	4.5	5.4
8	5.5	4.8	4.1	3.5	3.1	2.7	2.6	2.6	2.7	2.8	3.2	3.6	4.3	5.0	5.9
9	6.3	5.6	4.9	4.3	3.9	3.5	3.4	3.4	3.5	3.6	4.0	4.4	5.1	5.8	6.7
10	7.0	6.3	5.6	5.0	4.6	4.2	4.1	4.1	4.2	4.3	4.7	5.1	5.8	6.5	7.4
11	7.3	6.6	6.9	5.3	4.9	4.5	4.4	4.4	4.5	4.6	5.0	5.4	6.1	6.8	7.7

From *a* to *b* .... Diagram I.
From *c* to *d* .... Diagram II.

FROM SMALL LOW WATER TO LARGE HIGH WATER.

Days from moon's greatest declination.

Before—								After—							Hours of moon's transit.
7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
Ft.	Ft.	Ft.	Ft	Ft.	Ft.	Ft.	Ft.	Ft	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	
8.0	7.8	7.5	7.2	6.8	6.4	6.3	6.2	6.1	6.2	6.2	6.3	6.3	6.3	6.4	0
8.1	7.9	7.6	7.3	6.9	6.5	6.4	6.3	6.2	6.3	6.3	6.4	6.4	6.4	6.5	1
7.8	7.6	7.3	7.0	6.6	6.2	6.1	6.0	5.9	6.0	6.0	6.1	6.1	6.1	6.2	2
7.2	7.0	6.7	6.4	6.0	5.6	5.5	5.4	5.3	5.4	5.4	5.5	5.5	5.5	5.6	3
6.5	6.3	6.0	5.7	5.3	4.9	4.8	4.7	4.6	4.7	4.7	4.8	4.8	4.8	4.9	4
5.8	5.6	5.3	5.0	4.6	4.2	4.1	4.0	3.9	4.0	4.0	4.1	4.1	4.1	4.2	5
5.4	5.2	4.9	4.6	4.2	3.8	3.7	3.6	3.5	3.6	3.6	3.7	3.7	3.7	3.8	6
5.6	5.4	5.1	4.8	4.4	4.0	3.9	3.8	3.7	3.8	3.8	3.9	3.9	3.9	4.0	7
6.1	5.9	5.6	5.3	4.9	4.5	4.4	4.3	4.2	4.3	4.3	4.4	4.4	4.4	4.5	8
6.9	6.7	6.4	6.1	5.7	5.3	5.2	5.1	5.0	5.1	5.1	5.2	5.2	5.2	5.3	9
7.6	7.4	7.1	6.8	6.4	6.0	5.9	5.8	5.7	5.8	5.8	5.9	5.9	5.9	6.0	10
7.9	7.7	7.4	7.1	6.7	6.3	6.2	6.1	6.0	6.1	6.1	6.2	6.2	6.2	6.3	11

From *b* to *c* .... Diagram I.
From *d* to *e* .... Diagram II.

TABLE IX.—ASTORIA—Continued.

LARGE EBB TIDE, OR FROM LARGE HIGH WATER TO LARGE LOW WATER.

Days from moon's greatest declination.

Hours of moon's transit.	Before—								After—						
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7
	Ft	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft	Ft.	Ft.
0	7.0	7.7	8.4	9.0	9.4	9.8	9.9	9.9	9.8	9.7	9.3	8.9	8.2	7.5	6.6
1	7.1	7.8	8.5	9.1	9.5	9.9	10.0	10.0	9.9	9.8	9.4	9.0	8.3	7.6	6.7
2	6.8	7.5	8.2	8.8	9.2	9.6	9.7	9.7	9.6	9.5	9.1	8.7	8.0	7.3	6.4
3	6.2	6.9	7.6	8.2	8.6	9.0	9.1	9.1	9.0	8.9	8.5	8.1	7.4	6.7	5.8
4	5.5	6.2	6.9	7.5	7.9	8.3	8.4	8.4	8.3	8.2	7.8	7.4	6.7	6.0	5.1
5	4.8	5.5	6.2	6.8	7.2	7.6	7.7	7.7	7.6	7.5	7.1	6.7	6.0	5.3	4.4
6	4.4	5.1	5.8	6.4	6.8	7.2	7.3	7.3	7.2	7.1	6.7	6.3	5.6	4.9	4.0
7	4.6	5.3	6.0	6.6	7.0	7.4	7.5	7.5	7.4	7.3	6.9	6.5	5.8	5.1	4.2
8	5.1	5.8	6.5	7.1	7.5	7.9	8.0	8.0	7.9	7.8	7.4	7.0	6.3	5.6	4.7
9	5.9	6.6	7.3	7.9	8.3	8.7	8.8	8.8	8.7	8.6	8.2	7.8	7.1	6.4	5.5
10	6.6	7.3	8.0	8.6	9.0	9.4	9.5	9.5	9.4	9.3	8.9	8.5	7.8	7.1	6.2
11	6.9	7.6	8.3	8.9	9.3	9.7	9.8	9.8	9.7	9.6	9.2	8.8	8.1	7.4	7.5

From *c* to *d* .... Diagram I.
From *a* to *b* .... Diagram II.

FROM LARGE LOW WATER TO SMALL HIGH WATER.

Days from moon's greatest declination.

Before—								After—							Hours of moon's transit.
7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
Ft	Ft	Ft.	Ft.	Ft	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft	Ft.	
6.4	6.6	6.9	7.2	7.6	8.0	8.1	8.2	8.3	8.2	8.2	8.1	8.1	8.1	8.0	0
6.5	6.7	7.0	7.3	7.7	8.1	8.2	8.3	8.4	8.3	8.3	8.2	8.2	8.2	8.1	1
6.2	6.4	6.7	7.0	7.4	7.8	7.9	8.0	8.1	8.0	8.0	7.9	7.9	7.9	7.8	2
5.6	5.8	6.1	6.4	6.8	7.2	7.3	7.4	7.5	7.4	7.4	7.3	7.3	7.3	7.2	3
4.9	5.1	5.4	5.7	6.1	6.5	6.6	6.7	6.8	6.7	6.7	6.6	6.6	6.6	6.5	4
4.2	4.4	4.7	5.0	5.4	5.8	5.9	6.0	6.1	6.0	6.0	5.9	5.9	5.9	5.8	5
3.8	4.0	4.3	4.6	5.0	5.4	5.5	5.6	5.7	5.6	5.6	5.5	5.5	5.5	5.4	6
4.0	4.2	4.5	4.8	5.2	5.6	5.7	5.8	5.9	5.8	5.8	5.7	5.7	5.7	5.6	7
4.5	4.7	5.0	5.3	5.7	6.1	6.2	6.3	6.4	6.3	6.3	6.2	6.2	6.2	6.1	8
5.3	5.5	5.8	6.1	6.5	6.9	7.0	7.1	7.2	7.1	7.1	7.0	7.0	7.0	6.9	9
6.0	6.2	6.5	6.8	7.2	7.6	7.7	7.8	7.9	7.8	7.8	7.7	7.7	7.7	7.6	10
6.3	6.5	6.8	7.1	7.5	7.9	8.0	8.1	8.2	8.1	8.1	8.0	8.0	8.0	7.9	11

From *d* to *e* .... Diagram I.
From *b* to *e* .... Diagram II.

TABLE IX.—PORT TOWNSHEND.

Hours of moon's transit.	SMALL EBB TIDE, OR FROM SMALL HIGH WATER TO SMALL LOW WATER.															FROM SMALL LOW WATER TO LARGE HIGH WATER.															Hours of moon's transit.
	Days from moon's greatest declination.															Days from moon's greatest declination.															
	Before—								After—							Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	
0	4.5	5.6	6.9	8.0	8.6	8.9	8.8	8.8	8.7	8.7	8.5	8.0	7.3	6.6	5.5	3.5	3.9	4.6	6.0	7.2	8.4	9.0	9.5	9.6	9.4	9.2	8.7	8.2	7.9	7.1	0
1	4.5	5.6	6.9	8.0	8.6	8.9	8.8	8.8	8.7	8.7	8.5	8.0	7.3	6.6	5.5	3.5	3.9	4.6	6.0	7.2	8.4	9.0	9.5	9.6	9.4	9.2	8.7	8.2	7.9	7.1	1
2	4.4	5.5	6.8	7.9	8.5	8.8	8.7	8.7	8.6	8.6	8.4	7.9	7.2	6.5	5.4	3.4	3.8	4.5	5.9	7.1	8.3	8.9	9.4	9.5	9.3	9.1	8.6	8.1	7.8	7.0	2
3	4.1	5.2	6.5	7.6	8.2	8.5	8.4	8.4	8.3	8.3	8.1	7.6	6.9	6.2	5.1	3.1	3.5	4.2	5.6	6.8	8.0	8.6	9.1	9.2	9.0	8.8	8.3	7.8	7.5	6.7	3
4	3.5	4.6	5.9	7.6	7.6	7.9	7.8	7.8	7.7	7.7	7.5	7.0	6.3	5.6	4.5	2.5	2.9	3.6	5.0	6.2	7.4	8.0	8.5	8.6	8.4	8.2	7.7	7.2	6.9	6.1	4
5	3.1	4.2	5.5	6.6	7.2	7.5	7.4	7.4	7.3	7.3	7.1	6.6	5.9	5.2	4.1	2.1	2.5	3.2	4.6	5.8	7.0	7.6	8.1	8.2	8.0	7.8	7.3	6.8	6.5	5.7	5
6	3.1	4.2	5.5	6.6	7.2	7.5	7.4	7.4	7.3	7.3	7.1	6.6	5.9	5.2	4.1	2.1	2.5	3.2	4.6	5.8	7.0	7.6	8.1	8.2	8.0	7.8	7.3	6.8	6.5	5.7	6
7	3.3	4.4	5.7	6.8	7.4	7.7	7.6	7.6	7.5	7.5	7.3	6.8	6.1	5.4	4.3	2.3	2.7	3.4	4.8	6.0	7.2	7.8	8.3	8.4	8.2	8.0	7.5	7.0	6.7	5.9	7
8	3.5	4.6	5.9	7.0	7.6	7.9	7.8	7.8	7.7	7.7	7.5	7.0	6.3	5.6	4.5	2.5	2.9	3.6	5.0	6.2	7.4	8.0	8.5	8.6	8.4	8.2	7.7	7.2	6.9	6.1	8
9	3.7	4.8	6.1	7.2	7.8	8.1	8.0	8.0	7.9	7.9	7.7	7.2	6.5	5.8	4.7	2.7	3.1	3.8	5.2	6.4	7.6	8.2	8.7	8.8	8.6	8.4	7.9	7.4	7.1	6.3	9
10	4.1	5.2	6.5	7.6	8.2	8.5	8.4	8.4	8.3	8.3	8.1	7.6	6.9	6.2	5.1	3.1	3.5	4.2	5.6	6.8	8.0	8.6	9.1	9.2	9.0	8.8	8.3	7.8	7.5	6.7	10
11	4.4	5.5	6.8	7.9	8.5	8.8	8.7	8.7	8.6	8.6	8.4	7.9	7.2	6.5	5.4	3.4	3.8	4.5	5.9	7.1	8.3	8.9	9.4	9.5	9.3	9.1	8.6	8.1	7.8	7.0	11

TABLE IX.—PORT TOWNSHEND—Continued.

Hours of moon's transit.	LARGE EBB TIDE, OR FROM LARGE HIGH WATER TO LARGE LOW WATER.															FROM SMALL LOW WATER TO LARGE HIGH WATER.															Hours of moon's transit.
	Days from moon's greatest declination.															Days from moon's greatest declination.															
	Before—								After—							Before—								After—							
	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	
	Ft.	Ft.	Ft	Ft.	Ft.	Ft.	Ft.	Ft	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	
0	6.5	5.4	4.1	3.0	2.4	2.1	2.2	2.2	2.3	2.3	2.5	3.0	3.7	4.4	5.5	7.5	7.1	6.4	5.0	3.8	2.6	2.0	1.5	1.4	1.6	1.8	2.3	2.8	3.1	3.9	0
1	6.5	5.4	4.1	3.0	2.4	2.1	2.2	2.2	2.3	2.3	2.5	3.0	3.7	4.4	5.5	7.5	7.1	6.4	5.0	3.8	2.6	2.0	1.5	1.4	1.6	1.8	2.3	2.8	3.1	3.9	1
2	6.4	5.3	4.0	2.9	2.3	2.0	2.1	2.1	2.2	2.2	2.4	2.9	3.6	4.3	5.4	7.4	7.0	6.3	4.9	3.7	2.5	1.9	1.4	1.3	1.5	1.7	2.2	2.7	3.0	3.8	2
3	6.1	5.0	3.7	2.6	2.0	1.7	1.8	1.8	1.9	1.9	2.1	2.6	3.3	4.0	5.1	7.1	6.7	6.0	4.6	3.4	2.2	1.6	1.1	1.0	1.2	1.4	1.9	2.4	2.7	3.5	3
4	5.5	4.4	3.1	2.0	1.4	1.1	1.2	1.2	1.3	1.3	1.5	2.0	2.7	3.4	4.5	6.5	6.1	5.4	4.0	2.8	1.6	1.0	0.5	0.4	0.6	0.8	1.3	1.8	2.1	2.9	4
5	5.1	4.0	2.7	1.6	1.0	0.7	0.8	0.8	0.9	0.9	1.1	1.6	2.3	3.0	4.1	6.1	5.7	5.0	3.6	2.4	1.2	0.6	0.1	0.0	0.2	0.4	0.9	1.4	1.7	2.5	5
6	5.1	4.0	2.7	1.6	1.0	0.7	0.8	0.8	0.9	0.9	1.1	1.6	2.3	3.0	4.1	6.1	5.7	5.0	3.6	2.4	1.2	0.6	0.1	0.0	0.2	0.4	0.9	1.4	1.7	2.5	6
7	5.3	4.2	2.9	1.8	1.2	0.9	1.0	1.0	1.1	1.1	1.3	1.8	2.5	3.2	4.3	6.3	5.9	5.2	3.8	2.6	1.4	0.8	0.3	0.2	0.4	0.6	1.1	1.6	1.9	2.7	7
8	5.5	4.4	3.1	2.0	1.4	1.1	1.2	1.2	1.3	1.3	1.5	2.0	2.7	3.4	4.5	6.5	6.1	5.4	4.0	2.8	1.6	1.0	0.5	0.4	0.6	0.8	1.3	1.8	2.1	2.9	8
9	5.7	4.6	3.3	2.2	1.6	1.3	1.4	1.4	1.5	1.5	1.7	2.2	2.9	3.6	4.7	6.7	6.3	5.6	4.2	3.0	1.8	1.2	0.7	0.6	0.8	1.0	1.5	2.0	2.3	3.1	9
10	6.1	5.0	3.7	2.6	2.0	1.7	1.8	1.8	1.9	1.9	2.1	2.6	3.3	4.0	5.1	7.1	6.7	6.0	4.6	3.4	2.2	1.6	1.1	1.0	1.2	1.4	1.9	2.4	2.7	3.5	10
11	6.4	5.3	4.0	2.9	2.3	2.0	2.1	2.1	2.2	2.2	2.4	2.9	3.6	4.3	5.4	7.4	7.0	6.3	4.9	3.7	2.5	1.9	1.4	1.3	1.5	1.7	2.2	2.7	3.0	3.8	11

Example VII.—Thus, in Example VI, the high water of February 7 was found to be 3.3 feet above mean low water. The declination being south, Diagram I applies, and this high water is the small one. To obtain the fall of the next low water or small low water, we enter Table IX, for San Francisco, with 0*h.* of moon's transit, and two days after the greatest declination in the first part of the table, and find 1.9 foot, which will be the difference in height of this high and low water. Entering with the same transit and day in the second part, we find 3.0 feet, which is the rise of the large high above the small low water; the difference between 1.9 and 3.0 or 1.1 foot is the difference of height of the two successive high waters.

It is easy to see how, in this way, the soundings of a chart can be reduced to what they would be approximately at all the successive high and low waters. A similar set of tables is in preparation for Key West and some of the other ports on the Gulf of Mexico, where the tides are of the same character.

TIDES OF THE GULF OF MEXICO.

On the coast of Florida, from Cape Florida, around the Peninsula, to St. Mark's, the tides are of the ordinary kind, but with a daily inequality which, small at Cape Florida, goes on increasing as we proceed westward to the Tortugas. From the Tortugas to St. Mark's the daily inequality is large and sensibly the same, giving the tides a great resemblance to those of the Pacific coast, though the rise and fall is much smaller. Between St. Mark's and St. George's island, Apalachicola entrance, the tides change to the single day class, ebbing and flowing but once in the twenty-four (lunar) hours.

At St. George's island there are two tides a day, for three or four days, about the time of the moon's declination being zero. At other times there is but one tide a day, with a long stand at high water of from 6 to 9 hours. From Cape St. Blas to and including the mouth of the Mississippi the single day tides are very regular, and the small and irregular double tides appear only for two or three days, (and frequently even not at all,) about the time of zero declination of the moon. The stand at high and low water is comparatively short, seldom exceeding an hour.

To the west of the mouth of the Mississippi the double tides reappear. At Isle Dernière they are distinct, though a little irregular, for three or four days, near the time of the moon's zero declination. At all other times the single day type prevails, the double tides modifying it, however, in the shape of a long stand of from 6 to 10 hours at high water. This stand is shortest at the time of the moon's greatest declination, sometimes being reduced to but one hour. At Calcasieu the tides are distinctly double, but with a large daily inequality. The rise and fall being small, they would often present to the ordinary observer the same appearance as at Isle Dernière. At Galveston the double tides are plainly perceptible, though small, for five or six days at the time of moon's zero declination. At other times they present the single day type, with the peculiarity that, after standing at high water for a short time, the water falls a small distance and stands again at that height for several hours, then continues to fall to low water. Sometimes it falls very slowly for nine or ten hours following high water, and then acquires a more rapid rate to low water. At Aransas Pass and Brazos Santiago the single day tides prevail. Small, irregular double tides are only perceived for two or three days at the moon's zero declination. At all other times there is but one high water in the day, with a long stand of from 6 to 9 hours, during which there are often small, irregular fluctuations or a very slow fall. In the following table the mean rise and fall of tides at the above stations are given.

The highest high and the lowest low waters occur when the greatest declination of the moon happens at full or change; the least tide when the moon's declination is nothing at the first or last quarter. The rise and fall being so small, the times and heights are both much influenced by the winds, and are thus rendered quite irregular.

TABLE X.

Rise and fall at several stations on the Gulf of Mexico.

Stations.	Mean rise and fall of tides.		
	Mean.	At moon's greatest declination.	At moon's least declination.
	Ft.	*Ft.*	*Ft.*
St. George's island, Florida	1.1	1.8	0.6
Pensacola, Florida	1.0	1.5	0.4
Fort Morgan, Mobile bay, Alabama	1.0	1.5	0.4
Cat island, Mississippi	1.3	1.9	0.6
Southwest Pass, Louisiana	1.1	1.4	0.5
Isle Dernière, Louisiana	1.4	2.2	0.7
Entrance to Lake Calcasieu, Louisiana	1.9	2.4	1.7
Galveston, Texas	1.1	1.6	0.8
Aransas Pass, Texas	1.1	1.8	0.6
Brazos Santiago, Texas	0.9	1.2	0.5

TO DETERMINE THE RISE AND FALL OF THE TIDES FOR ANY GIVEN TIME FROM HIGH OR LOW WATER.

It is sometimes desirable to know how far the tide will rise in a given time from low water, or fall in a given time from high water, or to approximate to the time which has elapsed from low or high water, by knowing the rise or fall of the tide in the interval. If the proportion of the rise and fall in a given time were the same in the different ports, this would easily be shown in a single table giving the proportional rise and fall, which, by referring to Table I, showing the rise and fall of the tide at the port, would give the rise and fall in feet and decimals. The proportion, however, is not the same in different ports, nor in the same ports for tides of different heights. The following Table XI shows the relation between the heights above low water for each half hour for New York and Old Point Comfort and for spring and neap tides at each place. Units express the total rise of high water above low water, and the figures opposite to each half hour denote the proportional fall of the tide from high water onward to low water. For example, at New York, three hours after high water, a spring tide has fallen six-tenths (sixty hundredths) of the whole fall. Suppose the whole rise and fall of that day to be 5.4 feet, (Table I,) then, three hours after high water, the tide will have fallen 3.24 feet, or three feet three inches, nearly. Conversely, if we have observed that a spring tide has fallen three feet three inches, we may know that high water has passed about three hours.

TABLE XI.

Giving the height of the tide above low water for every half hour before or after high water, the total range being taken as equal to 1.

Time before or after high water.	NEW YORK.		OLD POINT COMFORT.	
	Spring tide.	Neap tide.	Spring tide.	Neap tide.
h. m.	*h m*	*h. m.*	*h. m.*	*h. m.*
0 0	1.00	1.00	1.00	1.00
0 30	0.98	0.98	0.98	0.98
1 0	0.94	0.93	0.95	0.94
1 30	0.89	0.86	0.88	0.87
2 0	0.80	0.72	0.80	0.78
2 30	0.72	0.59	0.70	0.68
3 0	0.60	0.45	0.59	0.57
3 30	0.49	0.31	0.49	0.44
4 0	0.39	0.19	0.37	0.34
4 30	0.28	0.10	0.26	0.22
5 0	0.18	0.02	0.17	0.13
5 30	0.09	0.00	0.08	0.05
6 0	0.05	....	0.03	0.01
6 30	0.00	....	0.00	0.00

TIDES IN COASTING.

By observing the time of high water and low water along the coast we find the places at which they are the same. The map of co-tidal lines (Sketch No. 65, C. S. Rep., 1857,) shows that it is high water nearly at the same hour all along the coast from Sandy Hook to Cape Cañaveral; of course, not in the bays and harbors and up the rivers, but on the outer coast.

It is high water exactly at the same hour all along the line marked XII, seen on the chart, near Sandy Hook, and north and south of Hatteras, and, with small interruptions, at Cape Lookout and Cape Fear, all the way to near Cape Cañaveral. This same line extends eastward to near Block island, and south of Nantucket, and then passes away from our coast. At full and change of the moon, along this line, (approximately,) it is high water at XII o'clock, Greenwich time, the local time of high water depending upon the longitude of the place; or, to speak more correctly, in the average of a lunar month it is high water so many hours after the time of the moon's passing the meridian of Greenwich. By these lines, called co-tidal lines, we can determine what tidal currents the navigators must expect to meet in coasting; and for this purpose we divide the ports of the coast into two sets, those south and those north of New York.

The sailing lines of coasters bound to southern ports this side of the straits of Florida are marked upon the map, and also of those bound through the sounds to eastern ports, and, outside, to Halifax and European ports.

VESSELS TO AND FROM PORTS SOUTH OF NEW YORK.

South of Sandy Hook, New Jersey, the line of XII hours is nowhere more than 18 miles from the coast; that of XI¾ nowhere more than 35 miles; that of XI½ nowhere more than 48; and XI nowhere more than 110. The distance of these lines of XII to XI hours, (corresponding within four minutes to VII and VI of New York time,) from different parts of the coast, is shown from Table A, where the first column gives the name of the place, and the second, third, fourth, fifth, respectively, the distances of the co-tidal lines of XII, XI¾, XI½, and XI hours.

The distances are measured from the ports on perpendiculars to the co-tidal lines. They may be taken as if measured on the parallel of latitude at all the points for the line of XII hours, and at all between Sandy Hook and Cape Hatteras for the lines of XI¾ and XI½ hours.

A.

Names of locations.	Distance from coast, measured on perpendicular to co-tidal lines.			
	At XII hours.	At XI¾ hours.	At XI½ hours.	At XI hours.
	Naut. miles.	*Naut. miles.*	*Naut. miles.*	*Naut. miles.*
Sandy Hook	12	32	53	100
Barnegat	2	29	39	78
Cape May	15	30	46	92
Cape Henlopen	18	33	47	92
Assateague	7	22	36	82
Cape Henry	12	28	43	100
Cape Hatteras		8	20	63
Ocracoke inlet		11	26	71
Cape Lookout		7	18	56
Beaufort entrance, North Carolina	6	15	24	63
Cape Fear		6	16	55
Cape Roman		10	21	67
Charleston light	3	15	27	70
Port Royal entrance	5	17	29	78
Tybee entrance	6	17	31	82
St. Mary's entrance	12	25	40	110
St. John's entrance	17	35	48	
Cape Cañaveral	16			
Cape Florida				

The co-tidal lines are in such directions that at 10, 20, and 30 miles from the coast, between Sandy Hook and the St. John's, there is but a variation of seven minutes, and even to Cape Cañaveral only of eight minutes.

Keeping ten miles from the shore, the coaster would pass from XII hours at Sandy Hook to XI hours 45 minutes at Hatteras, and increase again irregularly to XII hours 7 minutes at the St. John's, as shown more explicitly in table B. These three tracks of 10, 20, and 30 miles are inside of the cold wall of the Gulf Stream, and generally in the cold current, except at Cape Cañaveral.

B.

Names of stations.	Co tidal hour at 10, 20, and 30 nautical miles from the coast, perpendicular to the coast.		
	Ten miles off.	Twenty miles off.	Thirty miles off.
	h m.	h. m.	h. m.
Sandy Hook	12 0	11 52	11 45
Barnegat	11 52	11 44	11 35
Cape May	12 5	11 53	11 45
Cape Henlopen	12 7	11 57	11 48
Assateague	12 0	11 48	11 37
Cape Henry	12 5	11 48	11 42
Cape Hatteras	11 45	11 30	11 22
Ocracoke inlet	11 47	11 36	11 25
Cape Lookout	11 45	11 30	11 20
Beaufort entrance, North Carolina	11 55	11 38	11 25
Cape Fear	11 38	11 25	11 18
Cape Roman	11 45	11 33	11 24
Charleston light	11 52	11 38	11 25
Port Royal entrance	11 57	11 45	11 32
Tyboe entrance	11 55	11 43	11 30
St. Mary's entrance	12 8	11 57	11 47
St. John's entrance	12 7	11 57	11 50
Cape Cañaveral	12 8	....	....
Cape Florida	13 10	....	....

It follows, then, as a general thing, from these two tables that the coaster, in passing from Sandy Hook to the St. John's would have the tides the same, within some fifteen minutes, as if he remained at Sandy Hook. So that leaving, for example, a high water, he would, according to the elapsed time, have the ebb and flood alternating every six hours and a quarter, nearly, as if he had remained near Sandy Hook. As the flood tide sets in generally to the northward and on shore, and the ebb to the southward and off shore, he would know by the time that elapsed from his departure and the period of the tide at which he started what tidal currents he might expect to meet as he passed along the coast. This, of course, is not peculiar to Sandy Hook as a point of departure, but would be true for any of the entrances given in the table, taking care not to mistake the time of tides within for that at the entrance.

By referring to George W. Blunt, esq., I have obtained the tracks of sailing and steam vessels passing from New York to ports to the south of it, as shown by the lines on the chart accompanying this paper.—(See Sketch No. 65, C. S. Rep., 1857.) Tracing these on the map of co-tidal lines, I have determined how the navigator would find the tides as he passes from port to port. The results are shown in the annexed table, (C,) in which the port between which and Sandy Hook the mariner passes is at the head of the table, and, at the side, the place off which the co-tidal hours will be found, as stated in the table.

C.

Off—	Co tidal hours on sailing lines measured on parallel of latitudes of places named in the first column, between New York and—							
	Delaware bay.	Chesapeake bay.	Ocracoke inlet.	Cape Fear.	Charleston.	Savannah.	St. John's.	Cape Florida.
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
Sandy Hook	12 5	12 5	12 5	12 5	12 5	12 5	12 5	12 5
Barnegat	11 57	11 57	11 57	11 57	11 57	11 57	11 57	11 57
Cape May	12 10	11 52	11 45	11 45	11 45	11 45	11 45	11 45
Cape Henlopen	....	11 51	11 43	11 43	11 43	11 43	11 43	11 43
Assateague	....	11 55	11 33	11 33	11 33	11 33	11 33	11 33
Cape Henry	....	12 13	11 24	11 24	11 24	11 24	11 24	11 24
Cape Hatteras	....	....	11 48	11 48	11 48	11 48	11 48	11 48
Ocracoke inlet	....	....	....	11 42	11 42	11 42	11 42	11 42
Cape Lookout	....	....	....	11 39	11 39	11 39	11 32	11 24
Beaufort entrance	....	....	....	11 39	11 39	11 39	11 32	11 24
Cape Fear	....	....	....	....	11 36	11 36	11 24	11 0
Cape Roman	....	....	....	....	11 46	11 46	11 19	....
Charleston Light	....	....	....	....	....	11 52	11 18	....
Port Royal entrance	....	....	....	....	....	12 3	11 18	....
Tybee entrance	....	....	....	....	....	....	11 16	....
St. Mary's entrance	....	....	....	....	....	....	11 55	....
St. John's entrance	....	....	....	....	....	....	12 10	....
Cape Cañaveral	....	....	....	....	....	....	....	....
Cape Florida	....	....	....	....	....	....	....	....

Thus, from Sandy Hook to Delaware bay, starting with XII hours 5 minutes, off Barnegat there would be, at the same instant, XI hours 57 minutes, and off Cape May XII hours 10 minutes, so that the navigator would have the same succession of tides, whether he remained at Sandy Hook or passed onward to Delaware bay, or whether he came from Delaware bay to Sandy Hook. So from Sandy Hook to Charleston he will find, at the same instant, XII hours 5 minutes at Sandy Hook, XI hours 57 minutes off Barnegat, XI hours 45 minutes off Cape May, and so onward upon the parallels of latitude for the several points. *For all practical purposes, then, of coasting, the succession of the tides, and, of course, of the tidal currents of flood and ebb, will be the same as if the navigator remained stationary.* Leaving at low water, he will meet the flood for 6 hours 15 minutes, and then the ebb for another 6 hours 15 minutes, and so on. It is the simplest of all rules that has thus come out of this investigation. That remarkable change of the temperature between the waters of the inshore cold current, and the warm waters of the Gulf Stream, occuring in so short a distance that Lieutenant Bache called it the "cold wall," takes place at distances off the coast of from 170 to 29 miles, (see Table D,) between Sandy Hook and Cape Cañaveral, measured from the several points named in the table, at right angles to the direction of the course, or measured along the parallels of latitude of the points, at distance from 195 to 28 miles between Assateague and Cape Cañaveral.—(Table D.) The points where the parallels north of Assateague meet this division line have not been accurately determined.

The annexed table shows these distances, measured at right angles and on the parallels.

D.

Distance from coast to "cold wall" of Gulf Stream, off—	Measured at right angles to coast.	Measured on parallel of latitude.
	Naut. miles.	*Naut. miles.*
Sandy Hook	170	....
Barnegat	135	....
Cape May	137	....
Cape Henlopen	137	....
Assateague	95	195
Cape Henry	92	107
Cape Hatteras	30	31
Ocracoke inlet	53	52
Cape Lookout	53	65
Beaufort entrance	62	....
Cape Fear	54	97
Cape Roman	57	103
Charleston light	61	95
Port Royal entrance	79	97
Tybee entrance	79	95
St. Mary's	90	87
St. John's	85	82
Cape Cañaveral	29	28
Cape Florida	....	....

The coasting line of thirty miles keeps inside of the cold wall all the way to Cañaveral, and all the routes traced on the chart from Sandy Hook to southern ports are on the inside of it. The Gulf Stream lines drawn on the chart show how the route to Bermuda and to the Bahamas cuts the alternate bands of warm and cold water of the Gulf Stream.

Vessels to and from ports east of New York.

The plate shows the sailing lines of vessels bound from New York to eastern ports and to Halifax, outside. The annexed table (E) gives the Greenwich time of high water off the several points named in the first column on the routes to and from the places named in the heading of the table. The distances are measured at right angles to the co-tidal curves.

E.

Off—	Co-tidal hours on sailing lines between New York and—						
	Newport.	New Bedford.	Nantucket.	Boston.	Portsmouth.	Portland.	Halifax.
	h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
Sandy Hook	....	....	....	....	....	....	12 5
Throg's Point	16 16	16 16	16 16	16 16	16 16	16 16	....
Fisher's Island	13 48	13 48	13 48	13 48	13 48	13 48	....
Block island	12 16	12 16	12 16	12 16	12 16	12 16	11 30
Monomoy	....	....	....	16 10	16 10	16 10	....
Cape Cod	....	....	....	14 35	14 35	14 35	12 15
Cape Ann	....	....	....	....	15 00	14 40	....
Portland	....	....	....	....	....	15 30	....

In passing from New York to an eastern port, the first great change in the tides and tidal currents is between the East river and Long Island Sound; the difference between Governor's island and Negro Point, on Ward's island, at the eastern entrance to Hell Gate, is two hours and forty-five minutes. Between this point and Throg's Point the change is small. The mariner is now in the full tide of the sound, and between Throg's Point and Fisher's island there is a difference of time of but two hours and twenty minutes, the greatest part of which is at the head of the sound and at its entrance—that is, near Throg's Point and Fisher's island. From off New London to off Sand's Point the difference is but one hour and forty minutes; so that if the mariner, instead of remaining at Throg's Point, passes onward to Fisher's island, he would lose but half a tide in the whole passage. In other words, he would have the same succession of rise and fall, according to the time elapsed, whether stationary or passing onward within two hours and a half, or less than half a tide.

The tidal current lines show that even a less allowance is to be made for the change of current than for the change of tide, the difference in the change of current between Throg's Point and Fisher's island, along the middle of the sound, being of no practical importance. Passing out of Long Island Sound, the tidal hours grow earlier, until off Block island that of Sandy Hook is again reached. The co-tidal line of Sandy Hook and Block island being the same, it is the struggle of the same tide through New York bay and the narrow East river and obstructed Hell Gate, and through Fisher's island and Long Island Sound and to Throg's Point. The tidal currents meet near Throg's Point.

The lower part of Narragansett bay has the co-tidal hour XII hours nearly. Buzzard's bay has nearly the same co-tidal hour, the tide wave reaching the shore at nearly the same time all around the bay. It would be impossible to give in a small compass a minute account of the tides of Martha's Vineyard and Nantucket sound. In general it may be said that as far as Holmes' Hole and Wood's Hole they resemble those of Block island sound, and afterwards those of Monomoy at the eastern entrance; but this generalization is unsatisfactory without more details than there is space here to give. In these sounds takes place the remarkable change of between three and four hours, the greatest change of our coast, dislocating, as it were, the times of high water at places south and west and east and north of Nantucket. The whole of this change takes place between the eastern entrance of Nantucket sound and the western of Martha's Vineyard, giving rise to quite a complex condition of both tides and currents, which it has occupied much time to unravel. The dominant co-tidal line of our coast, from Block island to Cape Cañaveral, is that of XII hours of Greenwich time; that of our eastern coast, from Nantucket to Passamaquoddy, is, in general, XV hours. Passing out of Nantucket sound, coasters carry nearly the same co-tidal hour to Cape Cod, and thence vary their time about half an hour in passing to Boston, to Portsmouth, to Portland, or to Passamaquoddy. It has long been known that the tidal almanac for Boston might practically be used for eastern ports. Vessels from New York to Halifax, and New York to Europe, which keep outside, and should keep well off the Nantucket shoals, and off George's, as shown by the track on the chart, vary their co-tidal hour but little, keeping between the lines of XII and XI½ until quite well on their course, and beyond Cape Sable. The same rule will apply to their case as has been given for vessels between New York and a southern port.

APPENDIX No. 15.

Table showing the least water in the channels of certain harbors, rivers, and anchorages on the coasts of the United States; reprinted from the list of 1857 and revised with additions and tidal data.

Places.	Limits between which depths are given.	LEAST WATER IN CHANNEL WAY. Mean. Low water.	Mean. High water.	Spring tides. Low water.	Spring tides. High water.	Authorities.
		Feet.	*Feet.*	*Feet.*	*Feet.*	
Portland, Maine	From Cape Elizabeth to Portland light	45	53.9	44.5	54.4	
	*From Portland light to breakwater	36	44.9	35.5	45.4	
	From breakwater to end of Munjoy Point	30	38.9	29.5	39.4	C. S., 1850, 1853, and 1854.
	From breakwater to anchorage	16	24.9	15.5	25.4	
	Channel-way off town and wharves	27	35.9	26.5	36.4	
	From Munjoy to railroad bridge	19.5	28.4	19	28.9	
Portsmouth, N. H	From Whale's Back to Fort Constitution	42	50.6	41.4	51.3	
	From Fort Constitution to the Narrows	51	59.6	50.4	60.3	C. S., 1851.
	From the Narrows to the city	45	53.6	44.4	54.3	
	Off the wharves	63	71.6	62.4	72.3	
Newburyport	Over bar	7	14.8	6.6	15.7	
Ipswich	Over bar	7.5	16.1	6.6	16.8	C. S., 1857.
Annisquam	Over bar	6.5	15.5	5.6	16.4	
Gloucester	Channel into southeast harbor	30	38.9	29.1	39.8	
	Inner harbor channel to abreast Ten Pound Island light	31	39.9	30.1	40.8	C. S., 1854.
	Up into inner harbor	24	32.9	23.1	33.8	
Salem, Mass	Northern ship channel, between Baker's and Misery islands	52	61.2	51.3	61.9	
	Southern ship channel, passing Half-way Rock, Gooseberry and Eagle islands to the northward, and Cat island and Coney island to the southward	28	37.2	27.3	37.9	C. S., 1850 and 1851.
	Inside of Salem Neck	19	28.2	18.3	28.9	
Boston, Mass	Main ship channel, between Lovel's and Gallop's islands	28.5	38.5	27.8	39.1	
	Broad sound, south channel	19.5	29.5	18.8	30.1	
	President's roads, anchorage	31.5	41.5	30.8	42.1	C. S., 1846, 1847, 1848, and 1853.
	Main ship channel, between Governor's island and Castle island	18	28	17.3	28.6	
Plymouth	Entrance off Gurnet lights	21	31.2	20.3	31.7	
	South of Duxbury pier, in mid channel	48	58.2	47.3	58.7	
	Up to anchorage inside the pier-head on Long Beach	14	24.2	13.3	24.7	C. S., 1857.
	At anchorage inside the pier-head	24	34.2	23.3	34.7	
	Anchorage in the Cow Yard	24	34.2	23.3	34.7	
Narragansett bay to Prudence island.	Entering with Boston Neck on port hand, Beavertail and Dutch island lights on starboard hand, passing between Canonicut Point and Hope island	25	28.9	24.6	29.2	Com. Wadsworth, 1832.
	Entering with Beavertail light on the port and Castle Hill on starboard hand, up to Goat island	60	63.9	59.6	64.2	
	Anchorage southward and westward of Goat island	33	36.9	32.6	37.2	
	Abreast of wharves inside of Goat island	21	24.9	20.6	25.2	
	From Newport harbor, inside of Gull Rocks to Prudence island	31	34.9	30.6	35.2	C. S., 1848.
	To Mount Hope bay	42	45.9	41.6	46.2	
	To Mount Hope bay, with Cormorant Rock, Sachuest Point on port, and Saughkonnet Point on starboard hand	20	23.9	19.6	24.2	
New York	Gedney's channel	23	27.8	22.6	28.1	
	Swash channel	17	21.8	16.6	22.1	C. S., 1855 and 1856.
	Old South channel	21	25.8	20.6	26.1	
	Main ship channel, passing Sandy Hook to SW. spit buoy	31	35.8	30.6	36.1	
	Main ship channel, after passing SW. spit buoy on NE. course, one mile up the bay for New York	23	27.8	22.6	28.1	
Arthur's Kill	Anchorage at Perth Amboy	22	26.9	21.5	27.5	
	From anchorage to Woodbridge wharf	22	26.9	21.5	27.5	
	† From Woodbridge wharf to Rossville	13.5	18.6	13.0	19.2	C. S., 1855.
	‡ From Rossville to Chelsea	14	19.1	13.5	19.7	
	§ From Chelsea, in the western channel, to Elizabethport	13	18.1	12.5	18.7	
	‖ From Elizabethport to Shooter's island	6.5	10.9	6.0	11.5	
Kill van Kull	From Shooter's island to Bergen Point light-house	10	14.3	9.5	14.9	
	From Bergen Point light-house to New Brighton	27	31.3	26.5	31.9	
Newark bay	¶ From Bergen Point light-house to the mouth of Hackensack river	7	11.6	6.5	12.2	C. S., 1855.
Hudson river	From Castle Garden to Manhattanville	32	36.0	31.6	36.8	Do.
	From Manhattanville to Yonkers	27	30.8	26.7	31.3	Do.
	** From Yonkers to Piermont Ferry	39	42.6	38.7	43.0	C. S., 1853.
	†† From Piermont Ferry to Sing Sing	24.5	28.0	24.3	28.3	Do.
	From Sing Sing to Haverstraw	26	29.1	25.8	29.8	Do.
	From Haverstraw to Peekskill	27	30.1	26.8	30.8	C. S., 1854.

* The depth in channel way varies between 6 and 8½ fathoms.

† Two bars, each a quarter of a mile, have a less depth than 18 feet.

‡ A small shoal, with 12 feet, lies in the middle of the kill, opposite the wharf at Blazing Star; and another, with 10 feet, a quarter of a mile to the northward; but deeper water is found on east side of both.

§ A shoal, of 4 feet, obstructs the eastern channel, half way between Chelsea and its junction with the main channel.

‖ Channel very narrow in the vicinity of Black beacon.

¶ From Bergen Point light, half way to Newark Bay light-house, 17 feet may be carried.

** In a straight line.

†† A shoal of 21.5 feet occurs about a mile below Sing Sing.

APPENDIX No. 15—Continued.

Places.	Limits between which depths are given.	Least water in channel way. Mean. Low water.	Mean. High water.	Spring tides. Low water.	Spring tides. High water.	Authorities.
		Feet.	*Feet.*	*Feet.*	*Feet.*	
Delaware bay	* Main ship channel, passing Delaware breakwater	61	64.5	60.4	64.9	C. S., from 1840 to 1844, inclusive.
	Off Brandywine light house	43	46.5	42.4	46.9	
	Main ship channel, passing False Liston's tree to abreast of Bombay Hook light	27.5	33.4	27.3	34.2	
	Blake's channel, along Flogger shoal	13.5	19.4	13.3	20.2	
	Blake's channel, passing Mahon river light	13.5	19.4	13.3	20.2	
	Main ship channel approaching Liston's Point	20	25.9	19.8	26.7	
Delaware river	Main ship channel up to Reedy island	20	26	19.6	26.3	C. S., from 1840 to 1844, inclusive.
	Main ship channel, opposite Reedy Island light-house	24.5	30.5	24.1	30.8	
	Opposite Delaware City	30	36	29.6	36.3	
	Up to Christiana Creek light	20.5	27	20.3	27.2	
	Up to Marcus Hook	20.5	27	20.3	27.2	
	Opposite Chester	24.5	30.7	24.4	31.2	
	Bar off Hog island	18.5	24.7	18.4	25.2	
	Between Greenwich Point and Gloucester Point	31.5	37.5	31.4	38.2	
	From Greenwich Point up to Philadelphia	21.5	27.5	21.4	28.2	
Chesapeake bay	From capes at entrance to Hampton Roads	30	32.5	29.8	32.8	1852, 1853, and 1854.
	Anchorage in Hampton Roads	59	61.5	58.8	61.8	
	From Hampton Roads to Sewall's Point	25	27.5	24.8	27.8	
	South of Sewall's Point, (one mile and a half)	21	23.5	20.8	23.8	
	Up to Norfolk	23	25.5	22.8	25.8	
	From Hampton Roads to James river, entering to the northward of Newport News middle ground	22	24.5	21.7	24.8	
	From Hampton Roads to James river, entering to the southward of Newport News middle ground	27	29.5	26.7	29.8	
York river, Va	From abreast the tail of York spit up to Yorktown	33	35.5	32.7	35.8	
Elizabeth river, Va	Between Norfolk and navy yard	25.5	28	25.3	28.3	
Hatteras inlet, N. C	Entrance	19	21	18.9	21.1	1857.
	Anchorage in Oliver's channel	13	15	12.9	15.1	
	Over bulkhead into Pamplico sound	7	9	6.9	9.1	
Ocracoke inlet	Over bar	10	12.4	8.8	12.6	1857.
	Anchorage in Wallico's channel	19	21.4	18.8	21.6	
Albemarle sound	From light-boat off Caroon's Point to a line joining Powell's Point and shell bank, near the mouth of Currituck sound	7	....	....	....	1851.
	Thence up the sound to Martin's Point	5.5	....	....	....	
	From Martin's Point to Trout's Hole, south of Rattlesnake island	5	....	....	....	
North river, N. C	At entrance, and seven miles up from Albemarle sound	6.7	....	....	....	1850.
Beaufort, N. C	Main ship channel	15.5	18.3	15.3	18.6	1854.
	Through the Slue	7	9.8	6.8	10.1	1857.
Cape Fear	New Inlet bar	8	12.5	7.5	13	1857.
	Western bar	8	12.5	7.5	13	
Georgetown, S. C	Entrance to Winyah bay, East and Southeast Pass	7	10.8	6.7	11.3	1851, 1852, and 1853.
	Anchorage inside of North island	27	30.8	26.7	31.3	
	Up to Georgetown	9	12.6	8.7	13.1	
Bull's bay	Over bar	13	17.8	12.6	18.3	1857.
	At anchorage	21	25.8	20.6	26.3	
Charleston, S. C	Main bar	11	16.3	10.8	17.1	1857.
	North channel	10	15.3	9.8	16.1	
	Maffit's channel	11	16.3	10.8	17.1	1858.
North Edisto	East channel	11	16.8	10.5	17.4	1856.
	Southeast channel	13	18.8	12.5	19.4	
St. Helena sound	South Edisto channel	14	19.9	13.3	20.7	1856 and 1857.
	Southeast channel	10	15.9	9.3	16.7	
	South channel	17	22.9	16.3	23.7	
	East channel	8	13.9	7.3	14.7	
Port Royal	East channel	16	23	15.5	23.5	1855 and 1856.
	Southeast channel	20	27	19.5	27.5	
	South channel	18	25	17.5	25.5	
Tybee entrance	Bar near Tybee island	19	26	18.4	26.5	1851 and 1852.
	Tybee roads	31	38	30.4	38.5	
Savannah	Channel up to city, (Wrecks and Garden Bank)	11	17.5	10.6	18.2	Captain Gilmer, U. S. Engineers.—1856.
Doboy bar, (inlet)	Entrance over bar	15.5	22.1	14.7	22.5	1855.
	Anchorage in sound	24	30.6	23.2	31	
St. Simon's	Over bar at entrance	17	23.8	16.3	24.5	1855 and 1856.
	Entrance to sound	38	44.8	37.3	45.5	
	Turtle river up to Blythe island	21	27.8	20.3	28.5	
St. Mary's	Main ship channel over bar	14.5	20.3	14	20.7	1855, 1856, and 1857.
	Channel up to St. Mary's	19	24.9	18.5	25.2	
St. John's river, Fla	Over bar at entrance	7	11.5	6.4	11.9	1855.
	Channel passing up towards Jacksonville	23	25.1	22.5	25.5	
Florida reef	Approaches to the inside of the reef:					
	Cape Florida light house bearing W SW. ¾ W	20	21.5	19.9	21.7	1852.
	Entrance to the northward of Fowey Rocks; Soldier key bearing SW. ½ W	19	20.5	18.9	20.7	
	Entrance to Legaré anchorage	20	21.5	19.9	21.7	
	Turtle Harbor entrance	26	27.5	25.9	27.7	1854.
	Channel inside the reefs (Hawk channel) from entrance off Cape Florida light-house to Rodriguez key	11	12.5	10.9	12.7	
	Anchorage one mile from Indian key	21	22.8	20.7	23.1	
	Bahia Honda channel, west point of Bahia Honda bearing N.NW	18	19.3	17.7	19.5	
	Key Sambo channel, between Middle and Western Sambo	34	35.3	33.7	35.5	
	Inside the reef and steering W. by N. for buoy	14	15.3	13.7	15.5	

*Soundings varying between 10 and 15 fathoms.

APPENDIX No. 15—Continued.

Places.	Limits between which depths are given.	LEAST WATER IN CHANNEL WAY. Mean. Low water.	Mean. High water.	Spring tides. Low water.	Spring tides. High water.	Authorities.
		Feet.	*Feet.*	*Feet.*	*Feet.*	
Key West	Main ship channel to middle buoy on shoals	27	28.3	26.9	28.5	1850 and 1851.
	From shoals to anchorage	30	31.3	29.9	31.5	
	East channel, entering	30	31.3	29.9	31.5	
	On course N NW. ½ W. (light on O'Hara's observatory) and passing between shoals	28	29.3	27.9	29.5	
	From 14-feet shoals to anchorage	30	31.3	29.9	31.5	
	At anchorage	27	28.3	26.9	28.5	
	Rock Key channel	20	21.3	19.9	21.5	
	Sand Key channel	27	28.3	26.9	28.5	
	West channel	30	31.3	29.9	31.5	
	Northwest channel up to abreast Northwest light	15	16.3	14.9	16.5	
	Over Northwest channel bar	12	13.3	11.9	13.5	
Tortugas	Northwest channel	45	46.2	44.8	46.4	
	Southwest channel	54	55.2	53.8	55.4	
Tampa bay	Over bar	19	20.4	18.8	20.6	1855.
	Channel between Egmont and Passage key	17	18.4	16.8	18.6	
Waccasassa bay	Channel up to anchorage	8	10.6	7.7	10.9	1857.
Cedar keys	Main channel	9	11.6	8.7	11.9	1858.
	Northwest channel over bar	11	13.6	10.7	13.9	1854.
St. Mark's	Over bar	9	11.2	8.7	11.5	'856.
	Channel at Middle buoy	12	14.2	11.7	14.5	
	In mid-channel, off light-house	15	17.2	14.7	17.5	
	Up to Fort St. Mark's	7	9.2	6.7	9.5	1852.
St. George's sound	East entrance over bar	15.5	......	......	......	1858.
	Main ship channel	14	......	......	......	
	Swash channel	13	......	......	......	
	At anchorage	19	......	......	......	
Apalachicola	*Over bar	13	......	......	......	
	In mid-channel, off beacon on St. Vincent's island	39	......	......	......	
	Up to anchorage	10	......	......	......	
St. Andrew's bay	*Main ship channel, over bar	13	14	12.8	14.3	1855.
	Swash channel, over bar	7	8	6.8	8.3	
	West Pass, over bar	7	8	6.8	8.3	
Pensacola	*Over bar	22.5	23.5	22.3	23.8	1856.
	From bar to navy yard	27	28	26.8	28.3	
	Off wharf at Pensacola	21	22	20.8	22.3	
Mobile bay and river	*Over outer bar	21	22	20.7	22.2	1847 to 1852, inclusive.
	Main ship channel to Fort Morgan	36	37	35.7	37.2	
	To the upper fleet	12	13	11.7	13.2	
	*Grant's Pass	6.5	7.5	6.3	7.8	1847.
Mississippi sound	*From Grant's Pass to Pascagoula mail wharf	7.5	8.7	7.2	9	1851.
	Horn Island Pass, over bar	15	16.2	14.7	16.5	1853.
	Anchorage inside Horn island	19	20.2	18.7	20.5	1852 and 1853.
	Up to Pascagoula mail wharf	8	9.2	7.7	9.5	
Ship Island harbor	*Channel	19	20.3	18.7	20.6	1848.
	Northwest channel	19.5	20.8	19.2	21.1	
	Anchorage, Man-of-war harbor	18	19.3	17.7	19.6	
Cat Island harbor	*Ship channel	16	17.3	15.7	17.6	1848.
	South Pass	14	15.3	13.7	15.6	
	Shell Bank channel	15.2	16.5	14.9	16.8	
Mississippi delta	*Pass à l'Outre, North channel	9.5	10.6	9.3	10.7	1851 and 1852.
	South channel	12	13.1	11.8	13.2	
Northeast Pass	*Over bar, north entrance	9.5	10.6	9.3	10.7	
	Over bar, south entrance	9	10.1	8.8	10.2	
Southeast Pass	*Entering	10	11.1	9.8	11.2	
South Pass	*Channel	8	9.1	7.8	9.2	
Southwest Pass	*Channel	13	14.1	12.8	14.2	
Barrataria bay	*Over bar outside of Grand Pass	7.5	8.7	7.2	8.9	1852.
	Grand passage to Independence island	15	16.2	14.7	16.4	
Dernière or Last island	*Channel inside, and north of Ship Island Shoal light ship	27	28.4	26.7	28.8	1853.
	Channel north of Ship Island shoal, one mile from beach of Dernière island	14	15.4	13.7	15.8	1853.
Atchafalaya bay	*From entrance to Cut-off Channel buoy	8	9.6	7.6	10.0	1858.
	On the Narrows	6.5	8.1	6.1	8.5	
	On Bulkhead	6.5	8.1	6.1	8.5	
	Mouth of Atchafalaya river in mid channel	48	49.6	47.6	50.0	
Vermillion bay	*Over bar	5.5	7.4	5.3	7.6	1855.
	In mid-channel off light-house	42	43.6	41.6	44	
Calcasieu river	*Entrance over bar	5.5	7.4	5.3	7.6	1855.
Sabine Pass	*Across the bar	7.5	9	7.2	9.3	1853.
Galveston bay	*Entrance over bar	12	13.1	11.7	13.3	1853.
San Luis Pass	*Over bar	8	9.1	7.8	9.3	1853.
Brazos river	*Over bar	8	9.1	7.8	9.3	1858.
Matagorda bay	*Entrance over bar	9	10.1	8.8	10.3	1857.
Aransas Pass	*Aransas Pass	9	10.1	8.7	10.5	1853.
Rio Grande	*Channel	4	4.9	3.8	5	1853.

* The highest tides occur at the moon's greatest declination, and are applied in the column headed "spring tides."

APPENDIX No. 15—Continued.

Places.	Limits between which depths are given.	LEAST WATER IN CHANNEL WAY. Mean, lowest of day.		Spring tides, lowest of day. Mean.		Spring tides, lowest of day. Moon's greatest declination.		Date.
		Low water.	High water.	Low water.	High water.	Low water.	High water.	
		Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	
San Diego bay	Entrance	27.4	31.5	26.8	32.1	26.3	31.8	1851.
San Diego	Midway between south end of Zuniga shoal and Point Loma light-house, bearing N. 61½ W. by compass, distant nearly a statute mile	20	24.1	19.4	24.7	18.9	24.4	1856.
	Middle Ground light house, bearing N. 67¼ W. by compass, distant three-fourths of a statute mile	18	22.1	17.4	22.7	16.9	22.4	1856.
	Midway and nearly in range between Ballast Point and point opposite	22	26.1	21.4	26.7	20.9	26.4	1856.
	Abreast of La Plaza, 160 yards from shore	18	22.1	17.4	22.7	16.9	22.4	1856.
	At end of wharf, (Newtown)	23	27.1	22.4	27.7	21.9	27.4	1856.
San Clemente island, (SE. end.)	About midway between NE and SW. points at anchorage in deepest bight, 450 yards from shore	40	44.1	39.4	44.7	38.9	44.4	1856.
San Clemente island, (NW. end)	About 200 yards from shore at anchorage	36	40.1	35.4	40.7	34.9	40.4	1852.
Mission San Juan Capistrano.	At anchorage	42	46.1	41.4	46.7	40.9	46.4	1853.
Santa Catalina island, (SW. side.)	Anchorage in Catalina harbor	21	25.0	20.5	25.5	19.9	25.1	1852.
San Pedro	In range between Point Pedro and half a mile from Dead Man's island	18	22.0	17.5	22.5	16.9	22.1	1852.
Point Duma	Anchorage	54	58.0	53.5	58.5	52.9	58.1	1853.
San Buenaventura	At anchorage half a mile from shore	36	40.1	35.5	40.9	35.0	40.4	1855.
Santa Cruz island	Anchorage, Prisoner's harbor	75	79.1	74.5	79.9	74.0	79.4	1852.
Santa Barbara	Anchorage inside of Kelp, 450 yards from shore	18	22.1	17.5	22.9	17.0	22.4	1852.
San Miguel island	Anchorage, Cuyler's harbor	37	41.1	36.5	41.9	36.0	41.4	1852.
Coxo harbor	Anchorage	30	34.1	29.5	34.9	29.0	34.4	1852.
San Luis Obispo	Anchorage in harbor	33	36.9	32.3	37.4	31.7	37.1	1852.
San Simeon	Harbor anchorage	24	27.9	23.3	28.4	22.7	28.1	1852.
Monterey harbor	Anchorage	42	45.9	41.5	46.2	40.9	45.8	1852.
	Near shore	30	33.9	29.5	34.2	28.9	33.8	1852.
Santa Cruz harbor	Anchorage	27	30.9	26.5	31.2	25.9	30.8	1852.
San Francisco bay	From 4 fathom bank around to southern shore	28	32.2	27.6	32.6	26.9	32.4	1851.
	Anchorage off Rincon Point, 450 yards from shore	66	70.2	65.6	70.6	64.9	70.4	1851.
	Anchorage off Market Street wharf, San Francisco	54	58.2	53.6	58.6	52.9	58.4	1851.
	Off Cunningham's wharf	36	40.2	35.6	40.6	34.9	40.4	1851.
	Off Clark's Point, 450 yards from shore	42	46.2	41.6	46.6	40.9	46.4	1851.
San Francisco harbor	On the bar	33	37.2	32.6	37.6	31.9	37.4	1855.
	At best wharves	20	24.2	19.6	24.6	18.9	24.4	1855.
Mare Island straits	In mid channel, between Commission Rock and western shore	25	30.5	24.8	30.7	24.0	30.3	1856.
	In mid channel, between navy yard and Vallejo	25	30.5	24.8	30.7	24.0	30.3	1856.
Ballenas bay	Inside of breakers on Duxbury reef, about a mile from shore	24	28.2	23.6	28.6	22.9	28.4	1853.
Sir Francis Drake's bay	Half a mile inside the point, and 400 yards from shore	17	21.2	16.6	21.6	15.9	21.4	1855.
Bodega bay	Half a mile inside of reef, at anchorage off point, 900 yards from shore	36	40.0	35.4	40.7	34.8	40.4	1853.
Coast	At Haven's anchorage	48	52.5	47.5	52.9	46.8	52.7	1853.
Albion river	Anchorage at entrance	48	52.5	47.5	52.9	46.8	52.7	1853.
Mendocino City	Anchorage inside of point	30	34.5	29.5	34.9	28.8	34.7	1853.
Shelter cove	Anchorage 500 yards inside of point	22	26.5	21.5	26.9	20.8	26.7	1853.
Humboldt bay	On bar, half a mile from shore	21	25.8	20.4	26.4	19.7	26.1	1853.
	Main channel	20	24.8	19.4	25.4	18.7	25.1	1851.
Crescent City harbor	Anchorage half a mile off Crescent City	21	26.2	20.4	26.9	19.7	26.5	1853.
Port Orford, or Ewing harbor.	Anchorage three-fourths of a mile from Tichenor's Rock, and half a mile from Battle Rock	46	51.7	45.4	52.4	44.7	52.0	1853.
Umpquah river	On bar, opposite mid-channel	13	19.1	12.4	19.6	11.7	19.3	1853.
Columbia river	North channel to Baker's bay	24	30.5	23.4	30.9	22.7	30.6	1852.
	*Entrance into south channel	19	25.5	18.4	25.9	17.7	25.6	1852.
	On bar of south channel	16	22.5	15.4	22.9	14.7	22.6	1853.
Shoalwater bay	On bar	18	24.5	17.1	25	16.4	24.5	1851.
	North channel	22.5	29	21.6	29.5	20.9	29	......
	South channel	25	31.5	24.1	32	23.4	31.5	1853.
Grenville harbor	Anchorage three-quarters of a mile inside of Point Grenville, and same distance from shore	22	28.5	21.1	29	20.4	28.5	1854.
Neé-ah harbor	Anchorage a mile inside of Waddah island, and 450 yards from shore	36	42.4	34.8	43.0	34.1	42.5	1851.
False Dungeness	Harbor anchorage	54	60.4	53.1	60.9	52.2	60.8	1853.
New Dungeness	do	45	51.4	41.1	51.7	43.2	51.8	1855.
Smith's island, (north side)	Anchorage near Kelp, 450 yards from shore	25	31.4	24.4	31.7	23.3	32.2	1854.
Bellingham bay	....	60	67	59.4	67.4	58.1	68	1855.
	Anchorage 400 yards southwest of Fitzhugh's wharf	18	25	17.4	25.4	16.1	26	1855.
Port Townshend	Anchorage 400 yards east of custom house	48	54.4	47.4	54.7	46.3	55.2	1854.
Port Ludlow	Anchorage	36	45.2	37.2	45.8	34.2	46.4	1855.
Port Gamble	do	18	27.2	17.2	27.8	16.2	28.4	1855.
Seattle	do	20	29.2	18.2	29.8	18.2	30.4	1854.
Blakely harbor	Anchorage 450 yards inside of entrance	46	55.2	45.2	55.8	44.2	56.4	1856.
Steilacoom harbor	Anchorage off Steilacoom creek, 400 yards	18	30.0	17.0	30.9	16.1	31.7	1855.
Olympia harbor	Mid channel, town 1½ mile distant, mission bearing E. NE	11	23	10	23.9	9.1	24.7	.....

* Twenty-one feet may be carried in at mean low water by keeping a little northward and westward, nearer the breakers of the middle sands, and, at the turn, hauling up for Cape Disappointment.

APPENDIX No. 16.

Table for navigators, showing the variation of the compass for the year 1858, *compiled from the general chart of F. J. Evans, R. N.*—(*See Sketch No.* 38.)

LATITUDE.	WEST LONGITUDE.																			LATITUDE.
	180°	170°	160°	150°	140°	130°	120°	110°	100°	90°	80°	70°	60°	50°	40°	30°	20°	10°	0°	
	VARIATION OF THE COMPASS.																			
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
60 N.	15½ E.	20¼ E.	25 E.	30 E.	33¼ E.	35 E.	....	....	19 E.	7 W.	39 W.	53 W.	56¼ W.	54¾ W.	50¾ W.	45¼ W.	39 W.	31 W.	24½ W.	60 N.
58	14¾	19½	23¾	28	30¾	31¾	....	....	....	0½ W.	31	45½ W.	51½	51	48	43½	37½	29¾	23¾	58
56	14½	18½	22½	26	28½	29	....	....	....	2½ E.	22½	....	46½	47	45½	41½	35½	28¾	23	56
54	13¾	17¾	21½	24½	26¾	27½	25½ E.	....	....	....	17	32¼ W.	41¾	43¾	43	39¾	34½	27¾	22½	54
52	13½	17½	20½	23	25	25½	24	....	....	....	12	27	36½	40¾	40¾	38	32¾	27½	21¾	52
50	13½	16¾	19½	21¾	23½	23½	22½	....	....	....	8 W.	22½	31½	37	38½	36½	31½	26½	21½	50
48	13½	16½	18¾	20½	22	22½	21	NOR	TH	....	....	18½	27½	33½	36	34½	30	25½	20½	48
46	13½	16	18	19½	20½	20¾	19½	AMER	ICA.	....	....	15½	24½	30	33½	32½	28¾	24½	20	46
44	13	15½	17½	18½	19½	19½	18½	....	....	....	....	13	21½	27½	30½	30½	27½	23½	19½	44
42	13	15½	16¾	17½	18½	18½	17½	....	....	....	....	11	18½	24¾	27¾	28½	26½	23	19½	42
40	13	14¾	16	16¾	17½	17½	16¾	....	....	....	0½ E.	9½	16½	22½	25¾	27	25½	22½	18¾	40
38	12¾	14½	15½	16	16½	16	15¾	....	....	....	1	7¾	14½	20½	24½	25¾	24¾	22	17½	38
36	12¾	14½	14½	15	15½	15½	14¾	....	....	....	1½	6	12½	18½	22½	24½	24	21½	17½ W.	36
34	12¾	14	14	14½	14½	14½	13¾	13¼ E.	....	8 E.	2½	4½	11	16½	21	23½	23½	21	....	34
32	12¾	13½	13½	13½	13½	13½	12¾	12½	....	7¾	2¾	3½	9½	14½	19½	22½	22½	20½	....	32
30	12½	13	12½	12½	12½	12½	12	11½	10¼ E.	7¾	3½	2½	7¾	13	17¾	21½	21¾	20	....	30
28	12½	12½	11½	11½	11½	11½	11½	11	10	7¾	4	1 W.	6½	11¾	16	20½	21	19¾	....	28
26	12	11¾	11	10¾	10¾	10¾	10½	10½	9½	7½	4½	0	5½	10½	14¾	19½	20½	....	....	26
24	11¾	11½	10½	10	11	10	10	9¾	9	7½	4¾	1 E.	4	9	13½	18¾	20	....	....	24
22	11½	10½	9¾	9½	9½	9½	9½	9½	8¾	7½	5½	2	3	8	12½	17½	19¾	AFR	ICA.	22
20	11½	10	9½	8¾	8½	8½	8½	8¾	8¾	7½	5½	2½	1¾	7	11½	16½	19½	....	....	20
18	10¾	9¾	9	8½	7¾	7½	7¾	8½	8½	7½	5½	3	0¾ W.	6	10¾	15¾	19	....	....	18
16	10½	9½	8¾	8	7	7	7½	7¾	8½	7½	6	3½	0½ E.	5	10	15	19	....	....	16
14	10	9½	8½	7½	6¾	6½	7	7½	8	7½	6½	3¾	1	4½	9½	14½	18½	....	....	14
12	9¾	9½	8½	7½	6½	6½	6½	7½	7¾	7¾	6½	4½	1¾	3½	8½	14	18½	....	....	12
10	9¾	9½	8½	7½	6½	6	6	7½	7¾	8	6¾	4½	2½	2¾	8	1[illegible]¾	18	19½ W.	....	10
8	9¾	9½	8	7	6½	5½	5¾	7	7¾	8½	7	5 E.	2½	2½	7¾	13½	17¾	19¾	19¾ W.	8
6	9½	9	8	7	6	5½	5½	7	7¾	8½	7½	....	2¾ E	1¾	7½	13	17¾	19¾	20½	6
4	9½	9	8	7	6	5	5½	7	7½	8½	8	....	....	1½	7	12¾	17½	20	20¾	4
2 N.	9½ E.	9 E.	8 E.	7 E.	5¾ E.	5 E.	5½ E.	7 E.	8 E.	9 E.	8½ E.	....	....	0¾ W.	6¾ W.	12¾ W.	17½ W.	20½ W.	21½ W.	2 N.

APPENDIX No. 16—Continued.

LATITUDE.	WEST LONGITUDE.																			LATITUDE.
	180°	170°	160°	150°	140°	130°	120°	110°	100°	90°	80°	70°	60°	50°	40°	30°	20°	10°	0°	
	VARIATION OF THE COMPASS.																			
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	9¼ E.	9 E.	8 E.	7 E.	5¾ E.	4¾ E.	5 E.	6¾ E.	8 E.	9½ E	8¾ E.	....	....	0¼ W.	6¼ W.	12¼ W.	17¾ W.	21 W	22¼ W	0
2S.	9¼	9	8	7	5¾	4¾	5	6¾	8½	9½	9	....	....	0½	6½	12½	17¾	21¼	22¾	2S.
4	9¼	9	8	7	5¼	5	5½	6¾	8¼	10	9¾	....	....	0	6½	12½	17¾	21¾	23½	4
6	9¼	9	8	7	6	5	5¼	7	8¾	10½	10	....	SOU	TH	....	12	18	22	23¾	6
8	9¼	9	8	7	6¼	5¼	5¾	7	9	10¾	10¼	....	AMER	ICA.	....	11¾	18	22½	24	8
10	9¼	9	8	7½	6¼	5¾	6	7¼	9¼	11	10¾	....	....	....	5¼ W.	11¼	18	22½	24¼	10
12	9¾	9	8½	7½	6¼	6	6½	7¼	9¾	11½	11½	....	....	....	5	11½	17¾	22½	24¾	12
14	9¾	9	8¼	7¼	6¼	6½	6¼	7¾	10	11¼	11¾	10 E.	....	....	4¾	11	17½	22¼	25	14
16	10	9½	8¼	7¼	6¾	6¼	6¾	8	10¼	12	12½	10½	....	....	4¼	10¾	17	22¼	25¼	16
18	10	9½	8¼	7¾	7	6¾	7	8¼	10¾	12½	12¾	10¾	....	....	4	10½	16¾	22½	25¼	18
20	10½	9¼	8¼	7¾	7½	7	7½	8¾	11	12¾	13½	11¼	....	2½ E	3¼	10	16½	22½	25¾	20
22	10¼	9¼	8¾	8	7¼	7½	7¼	9	11½	13	13¾	12	....	2¼	3½	9¼	15¾	21¾	25¾	22
24	10¾	9¼	8¾	8¼	7¼	7¼	7¾	9¼	11¾	13¼	14½	12¼	....	3	2¾	9	15¼	21¼	25¾	24
26	11	9¾	9	8½	7¾	7¼	8	9¾	12	14	14¾	13½	....	3¼	2½	8¼	15	21½	25½	26
28	11¾	10½	9½	8¼	8	8	8¼	10	12½	14½	15¼	14	....	4	1¾	8	14¼	20¾	25½	28
30	12	10¼	9¼	8¾	8½	8	8¾	10½	12¾	15	16	14¼	10½ E.	4¼	1½	7¼	13¾	20	25	30
32	12¼	11	9¾	9	8¼	8¼	9	10¾	13	15¼	16¼	15	10¾	5½	0¾ W.	7	13½	19¼	[illegible]	32
34	13	11¼	10	9	8¾	8¾	9½	11	13¼	16½	17½	15¼	11¼	5¾	0	6¼	12¾	18¾	24½	34
36	13¼	11¾	10½	9¼	9	9	9¾	11¼	14	16¾	17¾	16	12½	6¼	0¼ E.	5¾	12	18¼	[illegible]	36
38	14	12½	10¾	9¾	9½	9¼	10	12	14¼	17¼	18¼	16¼	12¾	7½	1½	5	11¼	17¼	23½	38
40	14¼	12¾	11½	10	9¾	9¾	10¼	12¼	15½	18¼	19½	17½	13½	8	1¾	4¼	10¾	16¾	22¼	40
42	15½	13¼	11¾	10¼	10	10	11	13	16	19	19¾	17¾	14	8¾	2¼	3¾	10½	16½	22	42
44	15¼	14	12½	11	10¼	10¼	11¼	13¼	16¾	20	20¼	18¼	14¼	9¼	3¼	3	9¼	15¼	21½	44
46	16	14½	12¾	11¼	11	11	12	14½	17¼	20¾	21½	19½	15½	10¼	4½	2½	8¾	14¼	20¼	46
48	16¼	15½	13½	12	11¼	11¼	12¾	15	18¼	21¼	22	20	16	11½	5	1¼	7¾	13¾	19¾	48
50	17½	15¾	14	12¾	12	12½	13½	16	19¾	22¼	22¾	20¾	16¼	11¾	6	1 W.	7	13	19	50
52	17¾	16½	14¾	13½	12¾	12¾	14	17	20½	23½	23¼	21¼	17¼	12¼	7	0	6	12½	18	52
54	18¼	16¾	15¼	14	13¼	13¼	15	18½	22	24½	24½	22½	18½	13¼	8	1 E.	5½	11½	17	54
56	19½	17¼	16	15	14½	14¼	16	19¼	23½	25	25½	23½	19½	14	8¾	2	4¼	10¼	16½	56
58	20	18¼	17	16	15¼	15¾	17¼	21¼	24¾	26½	26½	24¼	21	15½	9¾	3¾	3½	9¼	15¼	58
60S.	21½ E.	19¼ E.	18¼ E.	17¼ E	17 E.	17¼ E.	19¼ E.	23¼ E.	26¼ E.	27¼ E.	27¼ E.	25¾ E.	21¼ E.	16¼ E.	10¾ E.	4 E.	3 W.	9 W.	15 W.	60S.

APPENDIX No. 16—Continued.

LATITUDE.	EAST LONGITUDE. 0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	150°	160°	170°	180°	LATITUDE.
	VARIATION OF THE COMPASS.																			
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
60 N	24½ W.	17¾ W.	11 W	5 W.	....	....	....	....	....	....	....	....	....	....	3 W.	0	5¼ E.	10½ E	15½ E	60 N.
58	23¾	17¼	11	5¼ W	....	....	....	....	....	....	....	....	....	....	3¼	0¼ W	4¾	10	14¾	58
56	23	17	11	....	....	....	....	....	....	....	....	....	....	....	3½	0½	4½	9¾	14¼	56
54	22½	16½	11 W.	....	....	....	....	....	....	....	....	....	....	....	3½	0½	4½	9½	13¾	54
52	21¾	16¼ W.	....	....	....	....	....	....	....	....	....	....	....	....	3½	0½	4½	9½	13½	52
50	21¼	....	EUR	OPE.	....	....	....	....	....	....	....	....	....	....	3½	0½	4½	9¾	13½	50
48	20½	....	....	5¾ W.	2 W.	1½ E.	4 E.	....	AS	IA.	....	....	....	....	3½	0½	4½	9¾	13½	48
46	20	15¼ W.	....	6	2¼	1	4	....	....	....	....	....	....	5¼ W.	3¼	0¼ W.	4¾	9¾	13½	46
44	19½	15¼	10¾ W.	6	2½	0½ E.	3	....	....	....	....	....	....	4¾	3¼	0	5	9¾	13	44
42	19¼	15	10¾	6¼	2½	0	2½ E	....	....	....	....	....	3¼ W.	4½	3	0	5¼	10	13	42
40	18¾	11¾	10¾	6¼	2¾	0¼ W	....	....	....	....	....	....	3	4.	2¾	0¼ E.	5½	10	13	40
38	17½	14¾	10¾	6½	3 W.	0¾	....	....	....	....	....	....	2¾	3¾	2¾	0½	5½	10	12¾	38
36	17¼ W	14¾	10¾	6¾	....	1 W.	....	....	....	....	....	....	2½	3½	2½	0¾	5¾	10¼	12¾	36
34	....	14¾	11	6¾	....	....	....	....	....	....	....	....	2	3¼	2¼	1¼	6	10¼	12¾	34
32	....	14¾ W.	11	7	....	1½ W.	....	....	....	....	....	....	1¾	2¾	1¾	1½	6¼	10¼	12¾	32
30	....	....	11 W.	7¼ W.	....	1½	0¼ W	....	....	....	....	....	1½	2½	1½	2	6½	10¼	12½	30
28	....	....	....	....	....	1¾	0½	....	....	....	....	....	1	2	1½	2¼	6½	10¼	12¼	28
26	....	....	....	....	....	1¾	0¾	....	....	2½ E.	....	....	0¾	1¾	0¾	2½	6½	10¼	12	26
24	....	....	....	....	....	2	1	0¼ E.	....	2¼	....	1¼ E	0½	1½	0¼ W.	3	6¾	10¼	11¾	24
22	....	AFR	ICA.	....	4¾ W.	2¼ W	1	0	....	2¼	....	1½	0½	1¼	0	3¼	6¾	10¼	11½	22
20	....	....	....	....	5	....	1¼	0	1¼ E.	2½	....	1½	0¼ W.	1	0¼ E	3½	7	10½	11½	20
18	....	....	....	....	5	2¾ W	1¼	0	1	2	....	1¾	0	0¾	0½	3¾	7	10½	10¾	18
16	....	....	....	....	5½	3	1½	0	1	2	2½ E	1¾	0¼ E	0½	1	4	7½	10	10¼	16
14	....	....	....	....	5½	3	1½	0¼ W.	1	2	2¼	1¾	0½	0¼ W.	1½	4½	7½	9¾	10	14
12	....	....	....	....	5¾ W.	3½	1½	0½	0¾	1¾	2¼	1¾	0½	0	1¾	4½	7½	9½	9¾	12
10	....	....	....	....	....	3½	1¾	0½	0¾	1½	2	1¾	0¾	0½ E.	2	4½	7½	9½	9¾	10
8	19¾ W	18 W	....	....	....	3¾	1¾	0½	0½	1½	2	1½	0¾	0½	2¼	4¾	7¾	9½	9¾	8
6	20¼	19	....	....	....	4	2	0¾	0½	1¼	1¾	1½	0¾	1	2½	5	7¾	9½	9½	6
4	20¾	19¾	....	....	....	4½	2¼	0¾	0¼ E	1¼	1½	1½	1	1	2¾	5	7¾	9½	9½	4
2 N.	21½ W.	20½ W.	....	....	....	4½ W.	2¼ W.	1 W.	0	1 E.	1½ E.	1¼ E.	1 E.	1¼ E.	3 E.	5¼ E.	8 E.	9¼ E.	9½ E	2 N.

APPENDIX No. 16—Continued.

LATITUDE.	EAST LONGITUDE. 0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°	130°	140°	150°	160°	170°	180°	LATITUDE.
	VARIATION OF THE COMPASS.																			
°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	22½ W.	21½ W.	....	....	8 W.	4¾ W.	2¾ W.	1½ W.	0	0¾ E.	1½ E.	1½ E	1 E.	1½ E.	3 E.	5½ E.	8 E.	9½ E.	9½ E.	0
2 S.	22¾	22½	....	....	8½	5	3	1½	0¼ W.	0½	1½	1½	1	1½	3½	5½	8½	9½	9½	2 S.
4	23¼	23	....	....	9½	5½	3½	1¾	0½	0½	1	1	0¾	1½	3½	5¾	8½	9½	9½	4
6	23¾	23½	....	....	10	6	3¾	2	0¾	0¼ E.	0¾	0¾	0½	1½	3½	6	8½	9½	9½	6
8	24	24	....	....	11	6¾	4	2½	1½	0¼ W.	0½ E.	0½ E	0½ E.	1½	3¾	6½	8½	9½	9½	8
10	24½	24¾	....	....	12	7½	4½	2¾	1½	0½	0	0	0	1½	4	6½	8½	9½	9½	10
12	24¾	25½	....	....	13	8½	5	3½	2	1	0¾ W.	0½ W.	0¼ W	1½	4	6¾	8¾	9¾	9¾	12
14	25	25¾	....	....	14	9½	5¾	3¾	2½	1¾	1½	1	0½	1½	4½	7	8¾	9¾	9¾	14
16	25½	26½	....	....	15½	10½	6¾	4½	3	2½	2	1½	0¾	1½	4½	7½	9	10	10	16
18	25½	26¾	....	....	16½	11½	7½	5½	3¾	3	2¾	2	1	1½ E	4½ E.	7½	9½	10½	10	18
20	25¾	27	....	....	17¾	13	8¾	6½	4¾	4½	3½	2½	1½	....	....	7¾	9¾	10½	10½	20
22	25¾	27½	....	....	19	14½	10	7½	6½	5½	4½	3	1½ W	....	....	8	10	10¾	10½	22
24	25½	27¾	....	....	20½	15½	11¾	8¾	7¾	7	5¾	3½	AUST	RALIA.	....	8½	10½	11½	10¾	24
26	25½	28	....	....	21½	17	12½	10½	9½	8½	7½	4½	....	....	....	8½ E	10¾	11¾	11	26
28	25½	28	....	26½ W	23	18½	15	11½	10¾	10	8½	5¾	....	....	....	....	11	12½	11¾	28
30	25	28	29½ W.	27½	24½	20	16½	13¾	12½	11½	10	6¾	3½ W.	0½ E.	....	....	11½	12¾	12	30
32	24½	28	29½	28½	25½	21½	18	15½	13¾	13½	11½	8	3¾	0½	5¾ E.	9½ E.	12	13	12½	32
34	24½	27¾	29½	29½	26¾	23½	19¾	17½	15¾	15	12¾	9	4½	0½ E	6	9¾	12½	13½	13	34
36	23¾	27½	30	29¾	28	25	20½	19	17½	16½	14½	10	5½	0	6	10½	12¾	14	13½	36
38	23½	27½	30½	30½	29	26½	23½	20¾	19	17½	15½	11	5¾	0¼ W	6	10½	13½	14½	14	38
40	22½	27½	30½	31½	30	27¾	25½	22½	21	19½	16½	12	6½	0¾	6½	10¾	13½	14¾	14½	40
42	22	27	30½	31¾	31	29	26¾	24½	23	21	17¾	13	7	0¾	6½	11½	14	15½	15½	42
44	21½	26½	30	32½	32	30½	28½	26½	25½	23½	19½	14½	7¾	1½	6½	11½	14½	15¾	15½	44
46	20½	26	30	32½	33	31¾	30	28½	27½	25¾	21½	15¾	8½	1½	6½	12	14¾	16½	16	46
48	19¾	25½	29¾	32¾	33¾	33	31½	30	29½	28½	23½	17½	9½	2	6½	12½	15½	16¾	16½	48
50	19	24¾	29¾	33	34½	34½	33½	32½	32	30¾	26¾	19	10½	2½	6½	12¾	15¾	17½	17½	50
52	18	24	29½	33	35½	35½	35	35	35	33¾	29	21½	12	3	6½	13½	16½	18½	17¾	52
54	17	23½	29	33	35¾	36½	36¾	37½	37¾	36½	31¾	23¾	14 W	3½	6½	13¾	17½	19	18½	54
56	16½	22½	28½	33	36½	37½	38½	39½	40	39½	34½	26	....	4½	6	14½	18	20	19½	56
58	15½	21½	27¾	33	36½	38½	40	42½	43½	42¾	38	28½ W.	....	5½	6	14¾	19½	21	20	58
60 S.	15 W.	21 W.	27½ W.	33 W.	36¾ W	39 W.	42½ W.	45 W.	47 W.	46 W.	42 W.	....	....	6¾ W.	6 E.	14¾ E	21 E.	22 E.	21½ E.	60 S.

APPENDIX No. 17.

Report of Capt. W. R. Palmer, U. S. Topographical Engineers, Assistant Coast Survey in charge of the office, and sub-reports of the chiefs of office divisions.

COAST SURVEY OFFICE, *October* 1, 1859.

DEAR SIR: In conformity with the instructions of the Superintendent, I have the honor to submit herewith the usual annual reports of the chiefs of the different divisions of the Coast Survey office. These reports narrate with critical exactness the amount of work executed in this office since my first report, dated one year ago.

It will doubtless be apparent to the Superintendent, from a close examination of these reports, that the quantity of work done has been so great that it could only have been accomplished by steady industry and attention to duty on the part of those engaged in it.

The character of the work and the execution of the finished maps, in my judgment, merit high praise; yet the loss of some three or more able assistants during the past year is severely felt by this office; industry, zeal, and intelligence on the part of those who have succeeded to their duties will soon, I hope, enable them to thoroughly fill the places of their predecessors.

Three officers of the army, viz: First Lieut. J. C. Tidball, 2d artillery, First Lieut. R. Saxton, 4th artillery, and First Lieut. J. P. Roy, 2d infantry, have been detached from duty within the past year, and two officers only, viz: First Lieut. J. R. Smead, 2d artillery, and First Lieut. Thomas Wilson, 5th infantry, have been assigned to duty here.

I shall now refer to the different divisions of this office in their order of precedence, commencing with the—

Computing Division.—This division, the varied labors of which includes all the computations and comparisons necessary in the primary, secondary, and tertiary triangulations, the astronomical, chronometric, and magnetic observations, measurements of bases, and, in addition, many incidental calculations, remains under the charge of its experienced chief, Assistant C. A. Schott.

One of the computers (Mr. J. Wiessner) resigned on the 1st of April last, to join one of the western exploring expeditions. The report herewith submitted will furnish the Superintendent with the details of occupation of his six assistants and himself during the past year.

Tidal Division.—The tidal division is under the charge of Assistant L. F. Pourtales, who is assisted by five regular computers, and such "aids" as may be available from time to time in the intervals of their field service; their names and occupation are given in the annexed report of the chief of the division. In addition to the regular duties of this division, in reducing and furnishing to the office the requisite tidal data for our charts, it has other special occupations under the immediate direction of the Superintendent, as will be seen by reference to Appendix No. 27.

Drawing Division.—This division, First Lieutenant J. C. Tidball, 2d artillery, in charge until 30th of June last, has not only promptly executed the various demands that have been constantly made upon it, in the projecting, upon the sheets required by the parties in the field, of the astronomical and trigonometrical points, in the furnishing of many tracings for the different departments and bureaux of the government, for office use, for public corporations, and for

many private citizens, (these latter tracings being given only with the sanction of the honorable Secretary of the Treasury,) but has also with a reduced force gained a further advance upon the engraving. In the language of First Lieutenant T. Wilson, 5th infantry, who, three months since, succeeded to the charge of this division, "Confidence is felt in its ability to meet in a prompt and satisfactory manner every demand that can be made upon it."

The Superintendent will doubtless concur with me in the expression of regret which all who have been associated with him feel at the loss to this office of the services of First Lieutenant J. C. Tidball, 2d artillery. He received orders to join his regiment on the 12th of August last, thus dissolving his connection with this work.

Lieut. Wilson's report, hereto annexed, and the lists accompanying it, will acquaint the Superintendent with the progress of the division, and the special occupation of each of the draughtsmen during the past year.

Engraving Division.—The division of the Coast Survey office to which I deem it my duty most particularly to invite the attention of the Superintendent at the present time is that of the engraving, which, notwithstanding the increase in force in various grades of engravers a few years since, is hardly at the present time able to keep up with the Drawing Division. A thorough study of the details of this subject will, no doubt, enable us to apply the remedy. As you have this subject under special consideration, I do not deem it necessary at present to enlarge upon it.

The charge of this division for the first half of the year continued with First Lieut. Rufus Saxton, U. S. A., when his detail by the War Department for duty at the United States Military Academy, at West Point, deprived this office of his valuable services.

During the past six months Mr. Edward Wharton succeeded to the duties of Lieut. Saxton. His zeal and industry merit my commendation.

Electrotype Division.—Under the direction of Mr. George Mathiot, chief electrotypist, assisted by Mr. D. Hinkle, this division has made during the present year eighty-seven copies of engraved plates, eighty-three being for the use of this office and four for other departments of the government, thus preserving unimpaired our original or standard plates, and using, in lieu of them, the electrotypes for printing.

I had the honor to state, in my previous report, that increased success had followed the experiments in photography, especially with a view to its use in the preparation of the reductions from the original plane-table sheets, and I have now the satisfaction of stating that, to a great extent, these reductions have proved successful. I would instance that of coast chart No. 29, from Green Run inlet to Little Machipongo inlet, Virginia, a proof of which was submitted to the Superintendent on the 28th of July last, after having been engraved from the photographic reduction. I have examined with care the criticisms of both the Drawing and Engraving Divisions upon it; it has been pronounced accurate. The cost of this reduction did not exceed one-fourth the cost of making the same reduction by hand.

Two other reductions, viz: San Pablo, California, $\frac{1}{80000}$, and New York bay and harbor, also $\frac{1}{80000}$, having been subjected to the closest criticism of experts in both the Drawing and Engraving Division, and proving accurate, are being now engraved as received from the photographer.

The report of the chief electrotypist, hereto appended, promises additional results by the use of photography in other branches of the survey.

Archives and Library.—The arrangement for the archives continues unchanged. The very limited space remaining for the records of the survey at the date of the last annual report is being rapidly filled, and great inconvenience is felt from the want of sufficient room for the proper disposal of those turned in from day to day, from the various field and hydrographic parties. There have been added to the library, during the calendar year 1859, one hundred and sixteen volumes, of which fifty were presented to the survey from home departments and institutions, and from those of foreign governments.

Miscellaneous division.—As stated in my last annual report the miscellaneous division, consisting of the printing and distribution of maps, charts, and Coast Survey Reports, had only then been organized less than a year and had improved upon its previous separate working. The experience of the year exhibits a large advancement upon the results then stated, without an increase in the number of its employés. The number of impressions from Coast Survey maps, charts, and sketches printed, amounting to over fifteen thousand, including proofs for distribution, quarterly records, &c., against near twelve thousand of the previous year. With this increase, still, the number of impressions taken is scarcely up to the demand made upon the office by our sale agents and for the distribution to libraries and other institutions authorized by the Treasury Department, which amounted in the last year to far more than double the number distributed in the previous year, including seven thousand eight hundred impressions of thirteen charts, sent to the principal departments of the government to foreign institutions, &c., and to certain libraries and other public depositories designated by members of the House of Representatives in their respective districts throughout the entire country.

The distribution of the Superintendent's Annual Report for 1857, from the time of its reception from the congressional binders, was made in less time than in any previous year. The annual report for the past year, it is confidently hoped, will be ready for distribution by the commencement of the coming session of Congress. It will, doubtless, be a source of much regret to those who have heretofore received the results of the operations of the Coast Survey in this form, that the number of extra copies ordered by Congress was reduced to five thousand from the twenty thousand, heretofore distributed by members of Congress direct to their constituents, and from this office to foreign governments and institutions, the libraries of our vessels-of-war, of colleges, and scientific institutions, and to individuals interested in science, commerce, and navigation throughout the Union.

This division is under the charge of First Lieut. J. R. Smead, U. S. A., who, in June last, relieved his predecessor, First Lieut. J. P. Roy, U. S. A., the valuable services of the latter having been called for by the War Department.

I would respectfully call the attention of the Superintendent to the details of work as reported by Lieut. Smead, which is hereto submitted.

Carpentry.—The carpenters' work necessary for the use and transportation of instruments for the surveying parties has been at all times during the year promptly executed. There have been made twelve new stands and thirty-three fine cases for instruments; twenty-six drawing and plane-table boards; seven large cases for books, maps, and copper-plates; five large vats, and eighteen frames for electrotype and photograph purposes; patterns for castings, and one hundred and forty-three packing boxes; the wood-work for two self-registering tide-gauges, and new instruments for magnetic observations; a machine for winding sounding-lines, and a vibrating stand for comparing base rods. All the instruments sent to and returned from the field parties have been packed and unpacked, and repairs made where needed; fifty tin tubes

for filing original maps and charts have been painted and numbered, and the requisite repairs and additions made to the Coast Survey buildings.

The work of the carpenter's shop is executed by Mr. A. Yeatman, master carpenter, assisted by one carpenter and one apprentice.

Instrument Shop.—The instruments made during the year are twenty-eight geodetic, three astronomical, sixteen magnetic and telegraphic, twenty-two telegraphic, ten hydrographic, twelve drawing, sixty-two engraving, and nineteen miscellaneous. Repairs have been made upon sixty-seven geodetic, five astronomical, six magnetic and telegraphic, ninety-six topographic, sixty hydrographic, thirty-five drawing and engraving, and three miscellaneous instruments. The force employed consists of Mr. J. Vierbuchen, master instrument maker, whose services and management are satisfactory, and five instrument makers.

I would express my acknowledgments to Commander S. S. Lee, U. S. N., who has recently been assigned to the charge of the Hydrographic Division of this office; to Prof. W. P. Trowbridge, assistant in the Coast Survey; Samuel Hein, esq., general disbursing agent, and Joseph Saxton, esq., assistant to the superintendent of weights and measures, for their prompt and cheerful co-operation with, and aid rendered to, the office on all subjects pertaining to their respective duties.

First Lieut. A. P. Hill, 1st artillery, U. S. A., still acts as general assistant; his merits are so well known to the Superintendent that it is superfluous for me to enlarge upon them.

In concluding this report I would add that the chief clerk in my office, A. W. Russell, esq., performs his duties with characteristic industry and ability. I shall, from a sense of duty, in a separate communication, strongly recommend an increase to the compensation of one or more of the gentlemen comprising the clerical force of this office, in order that they may be placed more nearly upon an equality, as to pay, with those of no higher grade or merit in the other departments and bureaux of the government.

I have the honor to be, very respectfully, your obedient servant,

W. R. PALMER,

Capt. Topl. Engineers, Assist. C. S., in charge of office.

Prof. A. D. BACHE,

Superintendent U. S. Coast Survey.

Report of Assistant Charles A. Schott, in charge of the Computing Division.

COAST SURVEY OFFICE, *October* 1, 1859.

In conformity with the regulations of the office, the usual annual report on the occupation of the several computers for the year ending October 1, 1859, is herewith respectfully submitted.

During a part of the year the number of computers was less than in the previous year. Mr. J. Wiessner resigned his position in this division on the 1st of April, to join one of the western wagon-road expeditions. The somewhat contracted state of the records received in the first half of the year permitted to continue the reductions of the current work without filling the place vacated by Mr. Wiessner, although it necessitated an increase of, and close attention to, duty on the part of the computers in general.

During the month of July, in accordance with instructions received from the Superintendent,

I was engaged on a magnetic survey, extending to Sections I and II; these observations were partly reduced by myself, and fully discussed in regard to the secular change of the magnetic declination, on which subject a report at some length was submitted in answer to a call from the Superintendent. The least square reduction of the primary triangulation between Kent Island and Washington was considerably advanced by me and reported on. The ordinary routine business of the office has all been attended to; it comprises principally the furnishing of geographical positions to topographical and hydrographic parties, and the examinations and reports of all computations, discussions, and revisions, either geodetic, astronomical, or magnetic.

The general distribution of the reductions has remained the same as in last year. The following statement contains in detail the amount of work done by each computer during the year ending October 1.

Assistant Theodore W. Werner computed the triangulation between St. Helena and Calibogue sounds, Section V; reduced Assistant Gerdes' triangulation on the Mississippi delta; made out a least square abstract of horizontal angles at station Humpback, Section I; reduced and computed rectangular co-ordinates of the Charlotte harbor triangulation, Section VI. He also computed the triangulation of the Gulf of Georgia, Washington Territory; made a second calculation of the astronomical latitude of yard, Section II; reduced the triangulations of Chandeleur sound, Section VIII, and near the mouth of the Potomac, Section III; also the triangulation connecting St. George's and St. Mark's, Section VII, computing new L. M. Z. for the whole work; the reduction of the triangulation between Sapelo and St. Simon's, Section V, 1858–'59, completes the work.

Mr. Eugene Nulty computed the astronomical latitude of Pensacola and Warrington, Section VII; of Lower Mississippi, Section VIII, and the azimuth of Plantation Hill and Warrington, Section VII, and of Humpback, Section I; also, the latitude of Humpback, Rutherford Observatory, N. Y., and of New Orleans. He also made a second reduction of the Seaton latitude, and reduced time and azimuth, and the latitude at station Smithville, N. C.

Mr. James Main made the revision of the two independent computations of the following astronomical work: The azimuths at Santa Cruz, Section X; at Allston and New Cut, Section V, and of Plantation hill, Section VII; the latitudes at Allston, Breach inlet, East Base, and Savannah, in Section V; of Pensacola and Warrington, in Section VII; of Thomas' hill, Bangor, and Humpback, in Section 1; of New York city and Washington city. He also revised the magnetic reductions at Humpback and Mississippi city, computed the magnetic constants for magnet C. 6, and made a reduction of my magnetic observations in July last.

Dr. Gottlieb Rumpf attended to the revision and insertion of the geographical positions in the registers; made the second least square reduction of the horizontal angles at stations Hill, Causten, and Seminary, Section III; made a second reduction of the James river triangulation of 1857, revised the reduction of the Mississippi delta triangulation, reduced the triangulation of Tomales bay and Petaluma creek, Section X, and of Sub-Assistant Harris' triangulation in the vicinity of New Orleans. He also made a least square abstract of the horizontal angles of the primary triangulations in Section V, and assisted in the reduction of vertical angles for elevations in Section I. He also reduced Assistant Blunt's work on the Hudson river, completing the triangulation up to Hudson City; assisted me in the discussion of the secular change of the magnetic declination, and in the preparation of the list of geographical positions printed in this year's report.

Mr. John Weissner computed the triangulation of Sheepscot river, Section I, and assisted in

the discussion of some magnetic reductions; he also supplied the L. M. Z. to the observers' computation of the Tomales bay triangulation, assisted in the least square reduction of the primary triangulation near Washington, and in the computation of L. M. Z. to the triangulation near New Orleans. He completed the reduction of vertical angles for heights in the vicinity of the Sheepscot river, 1855-'57, and reduced vertical angles at stations Saunders, Sebattis, and Ragged, of the primary series. Mr. Wiessner's resignation took effect on the first of April last.

Mr. William D. Storke assisted in the reduction of horizontal angles at Humpback, Section I; reduced the triangulation on Pensacola bay, 1858, and of Sub-Assistant Bagwell's triangulation south of the Cedar Keys; computed the triangulation of Assistant Bolles', south and west of Cape Fear river entrance, 1855 to 1858; made himself acquainted with the reduction of transit observations, and assisted in the preparation of geographical positions for the present report. He also reduced the horizontal angles at Smithville, N. C., in connection with the astronomical azimuth; assisted Mr. Rumpf in the L. M. Z. computations on Hudson river triangulation, and also assisted in the preparation of the statistical table for this year.

Mr. John T. Hoover attended to the clerical duties of the division, and principally assisted in the preparation of the geographical positions for the 1859 report, duplicating and revising the same. He also made a number of diagrams.

R. Freeman supplied the extra copying required for field or office.

Report of Assistant L. F. Pourtales, in charge of Tidal Division.

COAST SURVEY OFFICE, *November* 1, 1859.

The following report on the occupation of the computers in this division during the past year is respectfully submitted:

Mr. R. S. Avery has finished the discussion of the nine years' series of tidal observations at Boston, and has made comparisons of twelve years' observations with the predictions made by means of the coefficients obtained. He has also prepared ephemerides for future years.

Mr. S. Walker has examined and registered the observations received from the tidal stations, and has had charge of the correspondence with the observers. He has also read off the sheets of the self-registering tide-gauges, and supervised the gauge established at the navy yard in this city, besides making miscellaneous computations.

Mr. John Downes has made graphical decompositions of the tidal curves of the Florida stations, and reductions and comparisons of the results obtained.

Sub-Assistant C. Fendall was attached temporarily to this division from April 11 to June 16, and made decompositions of the tidal curves from the Florida reef, and worked out the diurnal inequality for some of the same.

Mr. J. Gilliss was engaged from November 26 to January 17 in making ordinary reductions, working out daily inequalities, drawing diagrams, and miscellaneous work.

Mr. R. E. Evans joined the division May 25, and has since been engaged on ordinary reductions, diagrams, and decompositions of tidal curves.

Messrs. J. Donegan, O. Henrich, and T. C. Bowie were engaged for short periods, in the intervals of their field duties, in miscellaneous work, chiefly ordinary reductions of tides.

Mr. A. W. King made, during part of the year, ordinary first and second reductions by contract.

The meteorological observations of the Pacific coast have continued to be discussed by *M. Thomas*, who has also done miscellaneous work and copying.

Most of the reductions of the observations of the permanent stations were made by *S. D. Pendleton.*

Report of Lieut. Thomas Wilson, U. S. A., assistant in charge of the Drawing Division.

COAST SURVEY OFFICE, *November* 1, 1859.

Pursuant to instructions, the following report is respectfully submitted of the operations of the drawing division of the United States Coast Survey office during the past official year, under the supervision of my able predecessor, Lieut. J. C. Tidball, U. S. A., until the 30th of June last, and since then in the charge of the undersigned.

During this time I have had the benefit of the assistance of Mr. G. A. Porterfield, whose experience in the office of several years has been successfully given to further the best interests of the division.

It is a material and gratifying fact that the division has been equal to the demands upon it by the extensive operations of the field and afloat, and the work is marked with great accuracy and superior professional ability and elegance.

* * * * * * * * * *

Below are presented the details of the duties and labors of the several draughtsmen employed. This outline of the past year's labors of this division furnishes some idea of its ability for promptly realizing in form and presenting in tangible shape the topographical and hydrographical results of the active service in the field and afloat.

As an incident to the draughting duties proper, yet of no ordinary importance, is the exact and methodical arrangement of the returns of the field service and other archives on which our maps and charts are founded. This arrangement is kept up with punctilious attention, and in such a manner that now and hereafter the maps and charts produced can be brought to the immediate test as to accuracy of the original data upon which they are founded, or renewed in the future, should every vestige of our present labors disappear by time or circumstance. It is proper also to report that not only have we kept pace with the field service, furnished projections to field parties, made projections on copper, and attended to these and other miscellaneous duties, legitimate but incidental, yet also are we still in advance of the engraving division, as, indeed, our system requires; so that not a moment is lost, nor the least delay possible, in its receiving from our hands a constant and abundant supply of material. For the purpose of presenting this fact more practically to the Superintendent, the paper marked A has been prepared, that he may see at a glance how the work on the projects in the drawing division stands with regard to its engraving.

It is a gratifying fact, too, that in co-operating with the purposes of a just and prudential economy of the Superintendent, we have been able to realize his wishes in a reduction of three during the past year; and with our present reduced force, looking to its efficacy, zeal, and

energy, we feel confident in an ability promptly and satisfactorily to meet every demand that may be made upon this division of the United States Coast Survey Office.

Assistant W. M. C. Fairfax has been employed upon the reduction of topography of coast maps and charts No. 7, from Muscongus bay to Portland harbor, Me., scale $\frac{1}{80000}$; No. 10, from Ipswich harbor to Green's harbor, Mass., $\frac{1}{80000}$: No. 11, from Plymouth harbor to Hyannis harbor, Mass., $\frac{1}{80000}$; Nos. 35 and 36, Chesapeake bay, from Pocomoke sound to entrance, Md. and Va., $\frac{1}{80000}$; and No. 53, from Stono inlet to Fripp's inlet, S. C., $\frac{1}{80000}$.

Assistant M. J. McClery has drawn additions to the Congress map, $\frac{1}{1500000}$, and been occupied upon the topography of coast map and chart No. 21, New York harbor and vicinity, $\frac{1}{80000}$.

Mr. A. Boschke has been employed upon projects for maps and charts according to the general plan adopted for the eutire coast.

Mr. A. Lindenkohl has reduced the reconnaissance of the coast of Texas, from Matagorda Bay entrance to Aransas pass, $\frac{1}{200000}$; has made additions to Alden's reconnaissance of the western coast, $\frac{1}{1200000}$, and has been employed upon Cape Fear River entrances, N. C. comparative charts, 1851–'58, $\frac{1}{10000}$; coast map and chart, No. 58, from the St. Mary's to the St. John's river, Fla., $\frac{1}{80000}$; San Francisco bay, Cal., $\frac{1}{80000}$; projections for field parties; projections on copper and verifications; and has assisted in the application of photography to topographic reductions.

Mr. A. Balbach was employed upon the hydrography of coast maps and charts, No. 68, Florida reefs, from Key Biscayne to Carysfort reef, $\frac{1}{80000}$, and No. 72, (ditto,) from Key West to Marquesas keys, $\frac{1}{80000}$, until the 29th of November, when he was transferred to the hydrographic division.

Mr. E. Hergesheimer entered the office on the 13th of December, and has been engaged upon the hydrography of coast maps and charts, No. 14, from Cuttyhunk island to Block island, Mass. and R. I., $\frac{1}{80000}$; Nos. 70, 71, 72, Florida reefs, from Long Key to Marquesas keys, $\frac{1}{80000}$; San Francisco and San Pablo bays, Cal., $\frac{1}{80000}$; Boston harbor, Mass., (additions for new edition,) $\frac{1}{40000}$; Muskeget channel, (ditto,) $\frac{1}{60000}$; Humboldt bay, Cal., $\frac{1}{50000}$; general coast chart, No. IV, from Cape May, N. J., to Currituck, N. C., $\frac{1}{400000}$; drawings from microscopiç enlargement of specimens of bottom taken in deep sea soundings, Gulf Stream, and verifications and examinations.

Mr. W. P. Schultz has reduced St. George's sound, (eastern part,) Fla., $\frac{1}{40000}$; additions to Charleston harbor, (for new edition,) S. C., $\frac{1}{30000}$; has drawn diagrams illustrating changes of temperature in Gulf Stream, with depths, and has been employed upon the reduction of Patuxtent river, Md., $\frac{1}{60000}$, progress sketches, projects, and projections.

Mr. L. D. Williams has made additions to preliminary seacoast charts, Nos. 11 and 12, from Cape Hatteras to Cape Fear, N. C., $\frac{1}{200000}$; additions to Canal de Haro and Strait of Rosario, W. T., $\frac{1}{200000}$; and has been engaged upon Hudson river, from entrance to Sing Sing, N. Y., $\frac{1}{60000}$; general coast chart No. II, from Cape Ann to Gay Head, Mass. and R. I., $\frac{1}{400000}$; additions to Congress map, $\frac{1}{1500000}$; projections on copper; projections for field parties and verifications.

Mr. A. Strausz has been engaged upon the reduction of hydrography of coast maps and charts, Nos. 105, 106, 107, and 108, from Galveston bay to Lavacca bay, Texas, $\frac{1}{80000}$; No. 9, from Cape Neddick, Me., to Cape Ann, Mass., $\frac{1}{80000}$; No. 11, from Plymouth harbor to Hyannis harbor, Mass., $\frac{1}{80000}$; No. 33, Chesapeake bay, from the Hudson to the Potomac

river, Md., $\frac{1}{80000}$; No. 53, from Stono inlet to Fripp's inlet, S. C., $\frac{1}{80000}$; preliminary seacoast chart No. 3, from Cape Small Point., Me., to Cape Cod, Mass., $\frac{1}{200000}$; Cedar Keys, Fla., (additions for new edition,) $\frac{1}{10000}$, and verifications of hydrographic reductions.

Mr. W. T. Martin has been engaged upon the topography of coast maps and charts, No. 28, from Cape Henlopen, Del., to Green Run inlet, Md., $\frac{1}{80000}$; No. 71, Florida reefs, from Newfound Harbor key to Boca Grande key, $\frac{1}{80000}$; Nos. 107 and 108, from Oyster bay to Lavacca bay, Texas, $\frac{1}{80000}$, and verifications.

Mr. P. Witzel has drawn Sapelo sound, Ga., $\frac{1}{30000}$; Atchafalaya bay, La., $\frac{1}{60000}$; completed York river, from West Point to King's creek, Va., $\frac{1}{60000}$; and has been employed upon Kennebec river, from entrance to Bath, Me., $\frac{1}{30000}$; Portland harbor, Me., $\frac{1}{20000}$; coast maps and charts, No. 48, from Barren inlet to Lockwood's Folly inlet, N. C., $\frac{1}{80000}$; No. 88, from Choctawhatchee bay to Pensacola bay, Fla., $\frac{1}{80000}$; Cape Fear river entrances, (comparative charts, 1851–'58,) N. C., $\frac{1}{10000}$; projections for field parties and projections on copper.

Mr. S. B. Linton has been employed upon Apalachicola bay, Fla., $\frac{1}{40000}$; Charleston harbor, (additions for new edition,) S. C., $\frac{1}{30000}$; Lynn harbor, Mass., $\frac{1}{20000}$; lettering reductions; additions to progress sketches, and measurement of original topographic and hydrographic sheets.

Mr. F. Fairfax was occupied upon the topography of the upper sheet of James' river, Va., $\frac{1}{40000}$; the sketches of Port Townshend, W. T., $\frac{1}{40000}$, and Brazos River entrance, Texas, $\frac{1}{10000}$; progress sketches and tracings, until the 31st of March, when he left the office.

Mr. B. Hooe, jr., has been continued upon tracings.

Artificer J. A. Campbell, U. S. A., has continued upon tracings and statistics and in care of miscellaneous maps.

A.

GENERAL COAST CHARTS.—SCALE $\frac{1}{400000}$.						PRELIMINARY SEACOAST CHARTS.—SCALE $\frac{1}{800000}$.					
Nos.	Project approved.	Drawing.		Engraving.		Nos.	Project approved.	Drawing.		Engraving.	
		Commenced.	Completed.	Commenced.	Completed.			Commenced.	Completed.	Commenced.	Completed.
I	I					1					
II	II	II		II		2					
III	III		III		III	3	3	3		3	
IV	IV	IV				4	4		4		4
V	V	V				5					
VI	VI					6					
VII	VII					7					
VIII						8					
IX						9					
X						10					
XI						11		11		11	
XII						12		12			
XIII						13					
XIV						14		14		14	
XIV bis.						15					
XV						16					
						17					
						18					
						19	19	19		19	
						20	20	20			
						21					
						22					
						23					
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						28	28				
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						30	30				
						31	31	31		31	
						32					

A—Continued.

COAST MAPS AND CHARTS.—SCALE $\frac{1}{80000}$.

Nos.	Project approved.	Drawing. Commenced.	Drawing. Completed.	Engraving. Commenced.	Engraving. Completed.
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15	15		15		15
16	16		16		16
17	17		17		17
18	18		18		18
19	19		19		19
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22	22				
23	23				
24	24				
25	25		25		25
26	26		26		26
27	27		27		27
28	28	28			
29	29			29 (Phot.	red'n.)
30	30				
30 *bis.*	30 *bis.*				
31	31		31	31	
32	32		32	32	
33	33	33		33	
34	34	34		34	
35	35	35		35	
36	36	36		36	
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COAST MAPS AND CHARTS.—SCALE $\frac{1}{80000}$.

Nos.	Project approved.	Drawing. Commenced.	Drawing. Completed.	Engraving. Commenced.	Engraving. Completed.
57					
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107	107	107		107	
108	108	108			
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112					
113					

List of maps and sketches completed or in progress during the year ending November 1, 1859, arranged in order of sections.

Name.	Scale.	Description.	Remarks.
SECTION I.—*Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.*			
Progress sketch A	1-600,000		Completed.
Progress sketch A *bis*	1-400,000		Do.
Sheepscot river, Maine	1-40,000	Finished map	In progress.
Kennebec river, from entrance to Bath, Maine	1-30,000	......do	Do.
Portland harbor, Maine	1-20,000	......do	Do.
Preliminary sea-coast chart, No. 3, from Cape Small Point, Me., to Cape Cod, Mass	1-200,000	Preliminary chart	Do.
Coast map and chart, No. 9, from Cape Neddick, Me., to Cape Ann, Mass	1-80,000	Finished map and chart	Do.
General coast chart, No. 2, from Cape Ann, Mass., to Gay Head, R. I	1-400,000	Finished chart	Do.
Coast map and chart, No. 10, from Ipswich harbor to Green's harbor, Mass	1-80,000	Finished map and chart	Do.
Lynn harbor, Mass	1-20,000	Finished map	Completed.
Boston harbor, (new edition,) Mass	1-40,000	......do	Do.
Coast map and chart, No. 11, from Plymouth harbor to Hyannis harbor, Mass	1-80,000	Finished map and chart	In progress.
Muskeget channel, (new edition,) Mass	1-60,000	Preliminary chart	Completed.
Coast map and chart, No 14, from Cuttyhunk island, Mass., to Block island, R I	1-80,000	Finished map and chart	In progress.
SECTION II.—*Coast of Connecticut, New York, New Jersey and Delaware, north of Cape Henlopen.*			
Progress sketch B	1-400,000		Completed.
Coast map and chart, No. 21, New York bay and harbor	1-80,000	Finished map and chart	In progress.
Hudson river, from entrance to Sing Sing, N. Y	1-60,000	Finished map	Do.
SECTION III.—*Coast of Delaware, south of Cape Henlopen, Maryland and Virginia, north of Cape Henry.*			
Progress sketch C	1-400,000		Completed.
General coast chart, No. 4, from Cape May, N. J., to Currituck, N. C	1-400,000	Finished chart	In progress.
Coast map and chart, No. 28, from Cape Henlopen, Del., to Green Run inlet, Md	1-80,000	Finished map and chart	Do.
Coast map and chart, No. 29, from Green Run inlet, Md., to Little Machipongo inlet, Va	1-80,000	......do	In progress by photography.
Coast map and chart, No. 33, Chesapeake bay, from Hudson river to Potomac river, Md	1-80,000	......do	In progress.
Coast map and chart, No. 35, Chesapeake bay, from Pocomoke sound to York river, Va	1-80,000	......do	Do.
Coast map and chart, No 36, Chesapeake bay, from York river to entrance, Va	1-80,000	......do	Do.
York river, from West Point to King's creek, Va	1-60,000	Finished map	Completed.
James river, from Richmond to City Point, Va	1-40,000	......do	In progress.
SECTION IV.—*Coast of Virginia, south of Cape Henry, and North Carolina, north of Cape Fear.*			
Progress sketch D	1-600,000		Completed.
Preliminary sea-coast chart, No. 11, from Cape Hatteras to Cape Lookout, N. C	1-200,000	Preliminary chart	In progress.
Preliminary sea-coast chart, No. 12, from Cape Lookout to Cape Fear, N. C	1-200,000	......do	Do.
Coast map and chart, No. 48, Cape Fear and vicinity, N. C	1-80,000	Finished map and chart	Do.
Cape Fear river, New inlet, N. C	1-10,000	Comparative chart, 1851-'58	Completed.
Cape Fear river, southern entrance, N C	1-10,000	......do	Do.
Diagrams illustrating changes of temperature in the Gulf Stream, with depths		Diagrams	Do.

List of maps and sketches, &c.—Continued.

Name.	Scale.	Description.	Remarks.
SECTION V.—*Coast of North Carolina, south of Cape Fear, South Carolina, and Georgia.*			
Progress sketch E	1-600,000		Completed.
Coast map and chart, No. 53, from Stono inlet to Fripp's inlet, S. C	1-80,000	Finished map and chart	In progress.
Charleston harbor, (new edition,) S. C	1-30,000	Finished map	Completed.
Ossabaw sound, Ga	1-30,000	do	In progress.
Sapelo sound, Ga	1-30,000	do	Do.
SECTION VI.—*Coast of Florida, from St. Mary's river to St. Joseph's bay.*			
Progress sketch F, (showing a general reconnaissance)	1-1,200,000		Completed.
Progress sketch F, No. 2, (reefs and keys)	1-400,000		Do.
Coast map and chart, No. 58, from St. Mary's river to St. John's river	1-80,000	Finished map and chart	In progress.
Coast map and chart, No. 68, Florida reefs, from Key Biscayne to Carysfoot reef	1-80,000	do	Do.
Coast maps and charts, Nos. 70, 71, and 72, Florida reefs, from Long key to Marquesas keys	1-80,000	Finished maps and charts	Do.
SECTION VII.—*Coast of Florida, west of St. Joseph's bay, and Alabama, east of Mobile bay.*			
Progress sketch G	1-600,000		Completed.
Cedar keys, (new edition,) Fla	1-50,000	Preliminary chart	Do.
St. George's sound, (eastern part,) Fla	1-40,000	Finished map	In progress.
Apalachicola bay, Fla	1-40,000	do	Do.
Coast map and chart, No. 88, from Choctawhatchee bay to Pensacola bay, Fla	1-80,000	Finished map and chart	Do.
SECTION VIII.—*Coast of Alabama, west of Mobile bay, Mississippi and Louisiana, east of Vermilion bay.*			
Progress sketch H	1-600,000		Completed.
Atchafalaya bay, La	1-50,000	Preliminary chart	Do.
SECTION IX.—*Coast of Louisiana, west of Vermilion bay, and of Texas.*			
Progress sketch I	1-600,000		Completed.
Coast maps and charts, Nos. 105, 106, 107, and 108, from Galveston bay to Lavacca bay, Texas	1-80,000	Finished maps and charts	In progress.
Brazos river entrance, Texas	1-10,000	Sketch	Completed.
Coast of Texas, from Matagorda bay entrance to Aransas Pass, Texas	1-20,000	do	Do.
SECTION X.—*Coast of California.*			
Progress sketch J, (from San Diego to Point Sal)	1-600,000		Completed.
Progress sketch J, No. 2, (from Point Sal to Tomales bay)	1-600,000		Do.
Alden's reconnaissance of western coast, (additions)	1-1,200,000	Sketch	Do.
Western coast of United States, (additions)	1-7,000,000	do	Do.
San Francisco bay and vicinity	1-80,000	Finished map and chart	In progress.
SECTION XI.—*Coast of Oregon and Washington Territories.*			
Progress sketch K	1-600,000		Completed.
Canal de Haro and Strait of Rosario, (additions)	1-200,000	Sketch	Do.
Port Townshend, W. T	1-20,000	do	Do.
Sketch showing progress of the survey on the Atlantic, Gulf of Mexico, and Pacific coasts	1-5,000,000		Prepared by the Superintendent.
Diagrams illustrating discussion of magnetical and meteorological observations			Drawn in computing division.

Report of Mr. Edward Wharton, acting in charge of Engraving Division.

COAST SURVEY OFFICE, *October* 31, 1859.

I have the honor to present the annual report of the operations of this division during the year ending October 31, 1859.

The division remained under the charge of Lieut. Rufus Saxton, U. S. A., from the date of the last annual report until April 1, when he was relieved from duty. Since that time the division has been under my charge. The engraving force at present consists of twenty-one engravers, of various grades.

The division has met with a serious loss in the death of one of its oldest and most skilled engravers, Mr. F. Dankworth, who had been attached to the office since 1843, and whose death occurred last March. Mr. Dankworth ranked among the first topographical engravers in this country, and it gives me pleasure to testify to the faithfulness with which he discharged his duties, and the ability and skill he evinced in the execution of his work. His place will be difficult to supply.

The engraving of the finished maps of Patapsco river, Md.; entrance to Pensacola bay, Fla.; San Diego bay, Cal.; Mare Island straits, Cal.; and San Francisco bay, Cal., have been completed; and the two plates of the middle and eastern part of Long Island sound, commenced some years ago, have been also completed, to take the place of the two already published. Various changes and additions have also been made to the charts of Boston harbor and Charleston harbor.

The second class maps and sketches of Atchafalaya bay, La.; entrance to Brazos river, Texas; Humboldt bay, Cal.; Port Gamble, Port Townshend, and Semi-ah-moo bay, Washington Territory, have also been engraved, and a new edition of Canal de Haro and Strait of Rosario. The maps of Kennebec river, Maine, from entrance to Bath, and of Rockport harbor, Mass., have been published in a preliminary form.

The first class finished maps and charts, Nos. 12 and 13, $\frac{1}{80000}$, Eastern series, from Monomoy to Muskeget, and from Muskeget to New Bedford; and Chesapeake bay series, $\frac{1}{80000}$, Nos. 1, 2, 3, 4, 5, 6; coast charts Nos. 40 and 41, $\frac{1}{80000}$, Albemarle sound; No. 68, $\frac{1}{80000}$, Florida reefs, from Key Biscayne to Carysfort reef; Nos. 91 and 92, $\frac{1}{80000}$, Mississippi sound, from Bonsecours bay to Grand island; Nos. 106 and 107, $\frac{1}{80000}$, Texas, from Galveston bay to Matagorda bay, and San Pablo bay, Cal., $\frac{1}{50000}$, have made considerable progress towards completion; and the outlines of coast chart No. 29, from Green River inlet to Little Machipongo inlet, Del. and Md., have been engraved from a photographic reduction.

Mr. McCoy has completed the topography upon coast chart No. 13, Eastern series, No. 2, $\frac{1}{80000}$, and twelve views for coast charts Nos. 12, 13, and 14, extending from Monomoy to Newport.

Mr. Dankworth was engaged, up to the time of his death, upon the topography of coast chart No. 32, $\frac{1}{80000}$, Chesapeake bay, from Magothy river to Hudson river.

Mr. Enthoffer has executed all the topography upon coast chart No. 33, $\frac{1}{80000}$, Chesapeake bay, from Hudson river to Potomac river.

Mr. Knight has been employed upon the soundings and miscellaneous lettering of coast charts Nos. 15 and 16, $\frac{1}{80000}$, Long Island sound; the soundings of coast chart No. 13, $\frac{1}{80000}$, Eastern series, No. 2; Nos. 34 and 35, Chesapeake bay, from Potomac river to York river, Va., $\frac{1}{80000}$;

Boston harbor, Mass; Patapsco river, Md.; Monterey bay, Cal.; and other miscellaneous lettering.

Mr. Rollé has nearly completed the topography of coast chart No. 31, Chesapeake bay, No. 1, $\frac{1}{80000}$, and has executed some miscellaneous work.

Mr. Sengteller has completed the topography of the lower part of coast chart No. 12, Eastern series, $\frac{1}{80000}$, and has also nearly completed that of the upper part.

Mr. Blondeau has completed the topography of entrance to San Francisco bay, $\frac{1}{50000}$, and has made considerable progress upon that of San Pablo bay, $\frac{1}{50000}$.

Mr. Phillips has finished the topography and one-half the sand of coast chart No. 92, Mississippi sound, from Round island to Grand island, $\frac{1}{80000}$, and has executed some miscellaneous work.

Mr. Metzeroth has completed the sand and views upon entrance to San Francisco bay, $\frac{1}{50000}$; the sand of San Diego bay, $\frac{1}{40000}$; and of the upper half of coast chart No 13, Eastern series, No. 2, $\frac{1}{80000}$, from Muskeget to New Bedford, and some miscellaneous work.

Mr. Barnard has engraved the sand upon coast chart No. 41, Albemarle sound, eastern part, $\frac{1}{80000}$; a portion of the sand upon general coast chart No. 2, from Cape Ann to Gay Head, Patapsco river, Md., and coast chart No. 92, Mississippi sound, $\frac{1}{80000}$, and miscellaneous work.

Mr. Kondrup engraved a portion of the outlines upon coast charts Nos. 32 and 34, Chesapeake bay, Nos. 2 and 4, $\frac{1}{80000}$; all the outlines, soundings, and general lettering upon the preliminary chart of Kennebec river, Maine; and is now engaged upon the topography of the same.

Mr. Evans has engraved portions of new work, and has made various corrections upon coast charts Nos. 15 and 16, Long Island sound, eastern and middle plates, $\frac{1}{80000}$; re-engraved the topography of Captain's island, E. and W., and new work upon the plate of Charleston harbor, $\frac{1}{50000}$.

Mr. Throop has engraved the soundings and bottoms of general coast chart No. 2, from Cape Ann to Gay Head; coast chart No. 41, Albermarle sound, east; and Sapelo sound, Georgia: the notes and lettering of Port Gamble, Humboldt bay, Pensacola bay, and executed other miscellaneous lettering; and is now engaged upon the notes of coast charts No. 91, Mississippi sound, from Bonsecours bay to Round island.

Mr. Maedel has engraved the topography and sand of Port Gamble, Washington Territory; the sand of Rockport harbor, Mass., Muskeget channel, Mass., preliminary sea coast chart No. 14, from Cape Roman, S. C., to Tybee river, Georgia; a portion of the sand of entrance to Cape Fear river, and miscellaneous work.

Mr. E. A. Maedel has engraved the title, notes, and soundings of coast chart No. 106, from Galveston bay to Oyster bay, Texas, and Rockport harbor, Mass.; the title and soundings of coast chart No. 107, from Oyster bay to Matagorda bay, and some miscellaneous work; and is now engaged upon the soundings of coast chart No. 71, Florida reefs, from Newfound Harbor key to Boca Grande key.

Mr. Petersen has engraved the title and notes of Canal de Haro and Strait of Rosario and of Semi-ah-moo bay, Washington Territory; a portion of the soundings of sea-coast chart No. 3, from Cape Small Pt., Maine, to Cape Cod, Mass; the notes of Patapsco river, Md., coast chart, No. 107, from Oyster bay to Matagorda bay, and of general coast chart No. 2, from Cape Ann to Gay Head; all the soundings of San Pablo bay, Cal., and the soundings of Pensacola harbor,

Fla., and miscellaneous work; and is now engaged upon the hydrography of New York bay and harbor, $\frac{1}{80000}$.

Mr. Langran has engraved the title, soundings, and notes of York river, Va., from King's creek to West Pt., Atchafalaya bay, La., Port Townshend, Washington Territory; a portion of the notes and soundings on sea-coast charts No. 11, from Cape Hatteras to Cape Lookout, and No. 14, from Cape Roman to Tybee river, and various miscellaneous lettering.

Mr. Ogilvie has engraved all the soundings, notes, and title on coast chart No. 68, Florida reefs, from Key Biscayne to Carysfort reef; a portion of the notes on sea-coast chart No. 4, from Cape Cod, Mass., to Saughkonnet Pt., R. I.; the soundings of Humboldt bay, Cal.; the general lettering on coast chart No. 41, Albermarle sound east, and other miscellaneous lettering.

Mr. Klakring has engraved all the topography, soundings, title and notes of Mare Island straits, Cal.; the topography of Humboldt bay, Cal.; and has executed some miscellaneous work; his employment by the office ceased on the 1st of July.

Mr. Bartle has engraved all the topography of Port Townshend, Washington Territory, and of entrance to Brazos river, Texas; and miscellaneous work upon various plates, and is now engaged upon the topography of Rockport harbor, Mass.

Messrs. *Benner*, *Thompson* and *Sipe* have been employed upon the engraving of progress and other sketches, and such miscellaneous work as was required by the office.

In addition to the amount of work performed by the engravers, five of the sketches for the Report of 1858, have been lithographed or engraved upon stone under the direction of the Superintendent of Public Printing.

A more detailed account of the work performed, progress made, &c., can be found in the accompanying list of maps, charts, preliminary charts, and sketches, engraved or engraving, during the year ending November 1, 1859, arranged in order of sections; and in the complete list of Coast Survey maps, charts, preliminary charts, and sketches engraved, and arranged geographically.

List of maps, preliminary charts, and sketches, engraved or engraving, during the year ending October 31, 1859, arranged in order of sections.

Name.	Scale.	Description.	Remarks.
SECTION I.			
Progress sketch A	1-400,000		Engraved.
Do. A *bis*	1-600,000		Do.
Kennebec river, Maine, from entrance to Bath	1-30,000	Preliminary chart	Do.
Rockport harbor, Mass	1-20,000	do	Do.
General coast chart, No. 2, from Cape Ann to Gay Head	1-400,000	General coast chart	Engraving.
Preliminary sea-coast chart, No. 3, from Cape Small Point, Maine, to Cape Cod, Mass	1-200,000	Preliminary chart	Do.
Preliminary sea-coast chart, No. 4, from Cape Cod, Mass, to Saughkonnet point, R. I.	1-200,000	do	Engraved.
Coast map and chart, No. 12, Eastern series, No. 3, from Monomoy to Muskeget, Mass	1-80,000	Finished map and chart	Engraving.
Coast map and chart, No. 13, Eastern series, No. 2, from Muskeget to Buzzard's bay	1-80,000	do	Do.
Coast map and chart, No. 14, Eastern series, No. 1, from Buzzard's bay to Narragansett bay	1-80,000	do	Do.
Kennebec river, Maine, from entrance to Bath	1-30,000	do	Do.
Rockport harbor, Mass	1-20,000	do	Do.
Lynn harbor, Mass	1-30,000	do	Do.
Muskeget channel, Mass., (new edition)	1-60,000	do	Do.

List of maps, preliminary charts, &c.—Continued.

Name.	Scale.	Description.	Remarks.
SECTION II.			
Progress Hudson river triangulation	1–400,000		Engraved.
Coast map and chart, No. 15, Long Island sound, east	1–80,000	Finished map and chart	Do.
Do do No. 16 do middle	1–80,000	do	Do.
Captain's island, east and west, (new edition)	1–20,000	Finished chart	Do.
Coast map and chart, No 21, New York bay and harbor	1–80,000	Finished map and chart	Engraving.
SECTION III.			
Progress sketch C	1–400,000		Engraved.
Coast map and chart, No. 31, Chesapeake bay, from head of bay to Magothy river, Maryland	1–80,000	Finished map and chart	Engraving.
Coast map and chart, No. 32, Chesapeake bay, from Magothy river to Hudson river, Maryland	1–80,000	do	Do.
Coast map and chart, No. 33, Chesapeake bay, from Hudson river to Potomac river, Maryland	1–80,000	do	Do.
Coast map and chart, No. 34, Chesapeake bay, from Potomac river to Pocomoke sound, Virginia	1–80,000	do	Do.
Coast map and chart, No. 35, Chesapeake bay, from Pocomoke sound to York river, Virginia	1–80,000	do	Do.
Coast map and chart, No. 36, Chesapeake bay, from York river Virginia to entrance of bay	1–80,000	do	Do.
Patapsco river, Maryland	1–60,000	Finished chart	Engraved.
York river, Virginia, from King's creek to West point	1–60,000	Preliminary chart	Engraving.
Coast map and chart, No 29, from Green Run inlet to Little Machipongo inlet, Delaware and Maryland	1–80,000	Finished map and chart	Do.
SECTION IV.			
Progress sketch D	1–400,000		Engraved.
Coast map and chart, No. 40, Albemarle sound west, from head of sound to Pasquotank river, North Carolina	1–80,000	Finished map and chart	Engraving.
Coast map and chart, No. 41, Albemarle sound east, from Pasquotank and Alligator rivers, to entrance, North Carolina	1–80,000	do	Do.
Preliminary sea-coast chart, No. 11, from Cape Hatteras to Cape Lookout, North Carolina	1–200,000	Preliminary chart	Do.
°Cape Fear river entrances, showing changes from 1851 to 1858, (two plates)	1–10,000	Comparative chart	Engraved.
SECTION V.			
Progress sketch E	1–600,000		Engraved.
Preliminary sea-coast chart, No. 14, from Cape Roman to Tybee, Georgia	1–200,000	Preliminary chart	Do.
Charleston harbor, (additions)	1–30,000	do	Do.
Sapelo sound, Georgia	1–30,000	do	Engraving.
SECTION VI.			
Progress sketch F	1–1,200,000		Engraved.
Progress sketch F, lower sheet, Florida keys	1–400,000		Do.
Coast map and chart, No. 68, Florida reefs, from Key Biscayne to Carysfort reef	1–80,000	Finished map and chart	Engraving.
SECTION VII.			
Progress sketch G	1–600,000		Engraved.
Entrance to Pensacola bay, Florida	1–30,000	Preliminary chart	Do.
Eastern part St. George's sound, Florida	1–40,000	do	Engraving.
°Apalachicola bay, Florida	1–40,000	do	Engraved.
SECTION VIII.			
Progress sketch H	1–600,000		Engraved.
Atchafalaya bay, La	1–50,000	Preliminary chart	Do.
Coast map and chart, No. 91, from Bonsecours bay to Round island, Miss	1–80,000	Finished map and chart	Engraving.
Coast map and chart, No. 92, from Round island to Grand island, Miss	1–80,000	do	Do.

List of maps, preliminary charts, &c.—Continued.

Name.	Scale.	Description.	Remarks.
SECTION IX.			
Progress sketch I	1–600,000		Engraved.
Entrance to Brazos river, Texas	1–10,000	Preliminary chart	Do.
Coast map and chart, No. 106, from Galveston bay to Oyster bay, Texas	1–80,000	Finished map and chart	Engraving.
Coast map and chart, No. 107, from Oyster bay to Matagorda bay, Texas	1–80,000	do	Do.
*Reconnaissance of coast of Texas, from Matagorda bay to Aransas Pass	1–200,000	Reconnaissance	Engraved.
SECTION X.			
Progress sketch J, lower sheet	1–600,000		Engraved.
Progress sketch J, middle sheet	1–600,000		Do.
San Diego bay, Cal	1–40,000	Finished chart	Do.
Mare Island straits, Cal	1–30,000	do	Do.
Entrance to San Francisco bay, Cal	1–50,000	do	Do.
San Pablo bay, Cal	1–50,000	do	Engraving.
Humboldt bay, Cal	1–30,000	P eliminary chart	Engraved.
*San Francisco city, Cal	1–10,000	Map	Do.
SECTION XI.			
Progress sketch K	1–600,000		Engraved.
Canal de Haro and Strait of Rosario, Washington Territory, (new edition)	1–200,000	Reconnaissance	Do.
Port Gamble, Washington Territory	1–20,000	Finished map	Do.
Port Townshend, Washington Territory	1–40,000	do	Do.
Semi-ah-moo bay, Washington Territory	1–30,000	Reconnaissance	Do.
MISCELLANEOUS			
Diagrams illustrating the descent of sounding weight and line in deep-sea soundings		Diagram	Engraved.
Project limits for finished maps, 1–80,000, on Atlantic and Gulf coasts	1–5,000,000	do	Do.
Sketch showing progress of coast survey to November, 1859	1–5,000,000	Sketch	Engraving.
Sketch showing limits of Gulf Stream	1–5,000,000	do	Do.
Diagrams of magnetical and meteorological observations at Girard College, Philadelphia, in 1840, 1841, 1842, 1843, 1844, and 1845		Diagram	Engraved.
Diagrams of observations for temperature, wind, and atmospheric pressure, made by Dr. E. K. Kane at Van Rensselaer harbor, in 1853 and 1855		do	Do.
Three sketches illustrating Superintendent's paper on currents of Sandy Hook		do	Do.

*Engraved on stone, under the direction of the Superintendent of Public Printing.

List of Coast Survey maps, preliminary charts, and sketches engraved, geographically arranged.

1. LIST OF MAPS AND CHARTS ENGRAVED.

No.	1.	Richmond's island, Maine	$\frac{1}{20000}$
	2.	Newburyport harbor, Massachusetts	$\frac{1}{20000}$
	3.	Ipswich and Annis Squam harbors, Massachusetts	$\frac{1}{20000}$
	4.	Gloucester harbor .... do	$\frac{1}{20000}$
	5.	Salem harbor .... do	$\frac{1}{25000}$
	6.	Boston harbor—new edition, 1859 .... do	$\frac{1}{40000}$
	7.	Plymouth harbor .... do	$\frac{1}{20000}$
	8.	Provincetown harbor .... do	$\frac{1}{80000}$

9.	Monomoy shoals .... Massachusetts	$\frac{1}{40000}$
10.	Bass River harbor .... do	$\frac{1}{40000}$
11.	Wellfleet harbor .... do	$\frac{1}{50000}$
12.	Nantucket harbor .... do	$\frac{1}{20000}$
13.	Hyannis harbor .... do	$\frac{1}{30000}$
14.	Harbor of Edgartown .... do	$\frac{1}{20000}$
15.	Harbor of Wood's Hole .... do	$\frac{1}{20000}$
16.	Harbors of Holmes's Hole and Tarpaulin Cove, Massachusetts	$\frac{1}{20000}$
17.	Harbor of New Bedford, Massachusetts	$\frac{1}{40000}$
18.	General chart of the coast from Gay Head to Cape Henlopen	$\frac{1}{400000}$
19.	Fisher's Island sound, Connecticut	$\frac{1}{40000}$
20.	Harbor of New London .... do	$\frac{1}{20000}$
21.	Mouth of Connecticut river · do	$\frac{1}{20000}$
22.	Harbor of New Haven, Connecticut—new edition, 1852	$\frac{1}{30000}$
23.	Harbors of Black Rock and Bridgeport, Connecticut—new edition, 1852	$\frac{1}{20000}$
24.	Harbors of Sheffield and Cawkin's Island .... do .... do 1852	$\frac{1}{20000}$
25.	Huntington bay, New York	$\frac{1}{30000}$
26.	Oyster bay or Syosset harbor, New York	$\frac{1}{30000}$
27.	Harbors of Captain's Islands, east and west, Connecticut	$\frac{1}{20000}$
28.	Hart and City islands, and Sachem's Head harbor, New York	$\frac{1}{10000}$, $\frac{1}{20000}$
29.	Hell Gate, New York	$\frac{1}{5000}$
30.	Long Island sound, east	$\frac{1}{80000}$
31.	Do ..... do .... middle	$\frac{1}{80000}$
32.	Do ..... do .... west	$\frac{1}{80000}$
33.	New York bay and harbor, and the environs, New York, sheet No. 1 ·	$\frac{1}{30000}$
34.	Do .... do .... do .... do .... do · · No. 2 ·	$\frac{1}{30000}$
35.	Do .... do .... do .... do .... do · · No. 3 ·	$\frac{1}{30000}$
36.	Do .... do .... do .... do .... do · · No. 4 ·	$\frac{1}{30000}$
37.	Do .... do .... do .... do .... do · · No. 5 ·	$\frac{1}{30000}$
38.	Do .... do .... do .... do .... do · · No. 6 ·	$\frac{1}{30000}$
39.	Do .... do .... do .... do	$\frac{1}{30000}$
40.	Western part of south coast of Long Island, New York	$\frac{1}{80000}$
41.	Middle part of .... do .... do .... do	$\frac{1}{80000}$
42.	Eastern part of .... do .... do .... do	$\frac{1}{80000}$
43.	Little Egg harbor, New Jersey	$\frac{1}{30000}$
44.	Delaware bay and river, sheet No. 1, Delaware	$\frac{1}{80000}$
45.	Do .... do ...... sheet No. 2, New Jersey and Pennsylvania · ·	$\frac{1}{80000}$
46.	Delaware bay and river, sheet No. 3	$\frac{1}{80000}$
47.	Patapsco river, Maryland	$\frac{1}{60000}$
48.	Harbor of Annapolis and Severn river, Maryland	$\frac{1}{60000}$
49.	Mouth of Chester river, Maryland	$\frac{1}{40000}$
50.	Entrance to York river, Virginia	$\frac{1}{60000}$
51.	Pasquotank river, North Carolina	$\frac{1}{60000}$
52.	Beaufort harbor .... do	$\frac{1}{20000}$
53.	Charleston harbor, South Carolina—new edition, 1858	$\frac{1}{30000}$

54.	Key West harbor and approaches, Florida	$\frac{1}{50000}$
55.	Entrance to Mobile bay, Alabama	$\frac{1}{40000}$
56.	Mobile bay, Alabama	$\frac{1}{80000}$
57.	Cat and Ship Island harbors, Mississippi	$\frac{1}{40000}$
58.	Entrance to Galveston bay, Texas—new edition, 1856	$\frac{1}{40000}$
59.	San Diego bay, California	$\frac{1}{40000}$
60.	Entrance to San Francisco bay, California	$\frac{1}{50000}$

2. List of Preliminary Charts and Sketches engraved.

1.	Alden's Rock, Maine	$\frac{1}{1000}$
2.	Eggemoggin reach, Maine	$\frac{1}{20000}$
3.	Kennebec river ...... do	$\frac{1}{30000}$
4.	Portland harbor ...... do	$\frac{1}{20000}$
5.	Portland harbor, (Commissioners' line,) Maine	$\frac{1}{10000}$
6.	York River harbor, Maine	$\frac{1}{20000}$
7.	Portsmouth harbor, New Hampshire	$\frac{1}{20000}$
8.	Rockport harbor, Massachusetts	$\frac{1}{20000}$
9.	Stellwagen's Bank—2d edition—Massachusetts	$\frac{1}{400000}$
10.	Boston bay ...... do	$\frac{1}{175000}$
11.	Current chart, Boston bay ...... do	$\frac{1}{100000}$
12.	Minot's ledge ...... do	$\frac{1}{10000}$
13.	Sea-coast of the United States, No. 4, south part of Massachusetts	$\frac{1}{200000}$
14.	Nantucket shoals, Massachusetts—new edition	$\frac{1}{200000}$
15.	Tidal currents, Nantucket shoals, Massachusetts	$\frac{1}{300000}$
16.	Muskeget channel ...... do	$\frac{1}{60000}$
17.	Sow and Pigs' reef ...... do	$\frac{1}{240}$ & $\frac{1}{20000}$
18.	Tidal currents, Long Island, New York	$\frac{1}{800000}$
19.	Pot Rock and Way's reef ...... do	
20.	Hudson river, lower sheet ...... do	$\frac{1}{60000}$
21.	Buttermilk channel ...... do	$\frac{1}{5000}$
22.	Beacon ranges, New York harbor	$\frac{1}{40000}$
23.	Romer shoals and Flynn's knoll, New York	$\frac{1}{40000}$
24.	Changes in Sandy Hook, New Jersey	$\frac{1}{10000}$ & $\frac{1}{40000}$
25.	Sea-coast of Delaware, Maryland, and part of Virginia	$\frac{1}{200000}$
26.	Delaware and Chesapeake bays	$\frac{1}{400000}$
27.	Chesapeake bay, (upper series,) Sheet No. 1	$\frac{1}{80000}$
28.	Do ...... do ...... do .. No. 2	$\frac{1}{80000}$
29.	Do ...... do ...... do .. No. 3	$\frac{1}{80000}$
30.	Chincoteague inlet, Virginia	$\frac{1}{40000}$
31.	Sea-coast of Virginia and entrance to Chesapeake bay, Virginia	$\frac{1}{200000}$
32.	James river, (upper sheet,) ...... do	$\frac{1}{40000}$
33.	Rappahannock river, No. 1 ...... do	$\frac{1}{20000}$
34.	Do ...... do .. No. 2 ...... do	$\frac{1}{20000}$
35.	Do ...... do .. No. 3 ...... do	$\frac{1}{5000}$
36.	Do ...... do .. No. 4 ...... do	$\frac{1}{20000}$

37.	Rappahannock river, No. 5	Virginia	$\frac{1}{60000}$
38.	Do ... do .. No. 6	do	$\frac{1}{60000}$
39.	York river, from King's creek to West Point	do	$\frac{1}{60000}$
40.	Wachapreague, Machipongo, and Metompkin inlets	do	$\frac{1}{40000}$
41.	Ship and Sand Shoal inlets	do	$\frac{1}{40000}$
42.	Entrance to Chesapeake bay	do	$\frac{1}{100000}$
43.	Cape Charles and vicinity	do	$\frac{1}{80000}$
44.	Cherrystone inlet	do	$\frac{1}{40000}$
45.	Pungoteague creek	do	$\frac{1}{40000}$
46.	Fishing or Donoho's battery, Maryland		$\frac{1}{80000}$
47.	Albemarle sound, North Carolina		$\frac{1}{200000}$
48.	Diagrams showing the effect of the wind in elevating and depressing the water in Albemarle sound.		
49.	Hatteras shoals, North Carolina		$\frac{1}{30000}$
50.	Cape Hatteras ... do		$\frac{1}{30000}$
51.	Hatteras inlet ... do ... fourth edition		$\frac{1}{30000}$
52.	Ocracoke inlet ... do		$\frac{1}{40000}$
53.	Sea-coast, North Carolina, from Hatteras to Ocracoke		$\frac{1}{200000}$
54.	Wimble shoals, North Carolina		$\frac{1}{80000}$
55.	Beaufort harbor ... do		$\frac{1}{20000}$
56.	New river and bar ... do		$\frac{1}{15000}$
57.	Frying-pan shoals ... do		$\frac{1}{120000}$
58.	Cape Fear river and New inlet, North Carolina		$\frac{1}{40000}$
59.	Entrance to Cape Fear river, (new edition,) North Carolina		$\frac{1}{30000}$
60.	Cape Fear river, from Federal Point to Wilmington, North Carolina		$\frac{1}{30000}$
61.	Gulf Stream explorations, 1853		$\frac{1}{3000000}$
62.	Diagrams, Gulf Stream explorations, 1853		
63.	Gulf Stream explorations, 1854		$\frac{1}{3000000}$
64.	Diagrams, Gulf Stream explorations, 1854		
65.	Gulf Stream explorations, 1855		$\frac{1}{3000000}$
66.	Co-tidal lines, Atlantic Coast		$\frac{1}{1000000}$ & $\frac{1}{1500000}$
67.	Diagrams of secular variation of magnetic dip, Atlantic coast		
68.	Cape Roman shoals, South Carolina		$\frac{1}{100000}$
69.	Sea-coast of the United States, No. 14, South Carolina		$\frac{1}{200000}$
70.	Winyah bay and Cape Roman shoals	do	$\frac{1}{100000}$
71.	Winyah bay and Georgetown harbor	do	$\frac{1}{40000}$
72.	Bull's bay	do	$\frac{1}{40000}$
73.	Comparative chart, Maffitt's channel, South Carolina, (new edition)		$\frac{1}{5000}$
74.	Maffitt's channel, (sections,) South Carolina		
75.	North Edisto river, (new edition,) .. do		$\frac{1}{30000}$
76.	Romerly marshes	do	$\frac{1}{10000}$
77.	Savannah river entrance, Georgia		$\frac{1}{30000}$
78.	Savannah city, front and back rivers, Georgia		$\frac{1}{20000}$
79.	Savannah river, Georgia		$\frac{1}{40000}$
80.	Doboy bar and inlet, Georgia		$\frac{1}{40000}$

81.	St. Simon's sound and Brunswick harbor, Georgia	$\frac{1}{40000}$
82.	St. Andrew's shoals ...... do	$\frac{1}{60000}$
83.	St. Mary's bar and Fernandina harbor, Florida—comparative chart	$\frac{1}{50000}$
84.	St. Mary's river and Fernandina harbor, Florida	$\frac{1}{20000}$
85.	St. John's river, from entrance to Brown's creek, Florida	$\frac{1}{25000}$
86.	Mosquito inlet ...... do	$\frac{1}{40000}$
87.	Cape Cañaveral ...... do	$\frac{1}{60000}$
88.	Florida reefs ...... do	$\frac{1}{300000}$
89.	Turtle harbor, Florida reefs ...... do	$\frac{1}{40000}$
90.	Beacons on Florida reefs ...... do	
91.	Coffin's Patches ...... do	$\frac{1}{50000}$
92.	Key Biscayne, Cape Sable and bases ...... do	$\frac{1}{400}$ & $\frac{1}{600000}$
93.	Legaré anchorage, (additions) ...... do	$\frac{1}{20000}$
94.	Key West harbor, Florida—second edition	$\frac{1}{100000}$
95–101.	Key West tidal diagrams, Florida	
102.	Rebecca shoals ...... do	$\frac{1}{600000}$
103.	Reconnaissance vicinity of Cedar Keys, Florida	$\frac{1}{300000}$
104.	Channel No. 4, Cedar Keys ...... do	$\frac{1}{50000}$
105.	Cedar Keys and approaches ...... do	$\frac{1}{50000}$
106.	Ocilla river ...... do	$\frac{1}{20000}$
107.	St. Mark's bar and channel ...... do	$\frac{1}{40000}$
108.	Middle, or main and western entrances, St. George's sound, Florida	$\frac{1}{60000}$
109.	St. Andrew's bay ...... do	$\frac{1}{40000}$
110.	Entrance to Pensacola bay ...... do	$\frac{1}{50000}$
111.	Sea-coast of part of Alabama and Mississippi	$\frac{1}{200000}$
112.	Mobile bay, (second edition,) Alabama	$\frac{1}{200000}$
113.	Horn Island Pass and Grand bay, Mississippi	$\frac{1}{300000}$
114.	Do ...... do ...... do .... new edition	$\frac{1}{40000}$
115.	Pascagoula river, Mississippi	$\frac{1}{50000}$
116.	Biloxi bay ...... do	$\frac{1}{40000}$
117–126.	Cat Island tidal diagrams ...... do	
127.	Pass Christian ...... do	$\frac{1}{40000}$
128.	Delta of the Mississippi, Louisiana	$\frac{1}{60000}$
129.	Gulf of Mexico, with profiles of deep-sea soundings—new edition	$\frac{1}{2400000}$
130.	Barataria bay entrance, Louisiana	$\frac{1}{50000}$
131.	Pass Fourchon ...... do	$\frac{1}{10000}$
132.	Timballier bay entrance ... do	$\frac{1}{20000}$
133.	Isle Dernière or Ship Island shoals, Louisiana	$\frac{1}{80000}$
134.	Atchafalaya bay ...... do	$\frac{1}{50000}$
135.	Entrances to Vermilion bay and Calcasieu river, Louisiana	$\frac{1}{50000}$ & $\frac{1}{40000}$
136.	Sabine Pass, Texas	$\frac{1}{40000}$
137.	Sea-coast of Texas from Galveston, south	$\frac{1}{200000}$
138.	Sea-coast of the United States, No. 31, part of Texas	$\frac{1}{200000}$
139.	San Luis Pass, Texas	$\frac{1}{20000}$
140.	Aransas Pass—2d edition—Texas	$\frac{1}{50000}$

141.	Entrance to Brazos river, Texas	$\frac{1}{10000}$
142.	Entrance to Rio Grande ... do	$\frac{1}{20000}$
143.	Diagrams of heights and lunitidal intervals of diurnal and semi-diurnal tides in the Gulf of Mexico	
144–145.	Co-tidal lines, Gulf of Mexico—2 plates	
146.	Type curves ... do	
147.	Wind curves, Cat island	
148.	Alden's reconnaissance Western Coast, lower sheet, San Francisco to San Diego—new edition—California	$\frac{1}{1200000}$
149.	Cortez bank	$\frac{1}{100000}$ & $\frac{1}{1200000}$
150.	San Diego entrance—new edition—California	$\frac{1}{150000}$ & $\frac{1}{25000}$
151.	Geological map of San Diego ... do	$\frac{1}{1608228}$
152.	Catalina harbor ... do	$\frac{1}{15000}$
153.	San Pedro anchorage and vicinity of Santa Barbara, California	$\frac{1}{20000}$ & $\frac{1}{40000}$
154.	Anacapa island, (sketch) ... do	
155.	Anacapa island and east end of Santa Cruz island, California	$\frac{1}{30000}$
156.	Prisoner's harbor, Cuyler's harbor, and northwest anchorage, San Clemente island, California	$\frac{1}{20000}$
157.	Santa Barbara, California	$\frac{1}{20000}$
158.	Eastern entrance to Santa Barbara channel, California	$\frac{1}{80000}$
159.	San Simeon, Santa Cruz, San Luis Obispo, and Coxo harbors, California	$\frac{1}{20000}$ & $\frac{1}{40000}$
160.	Point Conception ... do	$\frac{1}{40000}$
161.	Point Pinos ... do	$\frac{1}{20000}$
162.	Monterey harbor ... do	$\frac{1}{40000}$
163.	Monterey bay ... do	$\frac{1}{60000}$
164.	Geological map of Monterey ... do	$\frac{1}{150000}$
165.	Santa Cruz and Año Nuevo harbors ... do	$\frac{1}{1200000}$ & $\frac{1}{40000}$
166.	San Pedro harbor ... do	$\frac{1}{20000}$
167.	Entrance to San Francisco bay ... do	$\frac{1}{400000}$
168.	San Francisco city, (new edition) ... do	$\frac{1}{10000}$
169.	Geological map of San Francisco ... do	$\frac{1}{150000}$
170.	South Farallon island ... do	
171.	Tidal diagrams, Rincon Point ... do	
172.	Pulgas base ... do	$\frac{1}{40000}$ & $\frac{1}{400000}$
173.	San Antonio creek ... do	$\frac{1}{25000}$
174.	Mare Island straits ... do	$\frac{1}{30000}$
175.	Alden's reconnaissance Western Coast, middle sheet, San Francisco to Umpquah river, California and Oregon	$\frac{1}{1200000}$
176.	McArthur's reconnaissance Western Coast, from Monterey to mouth of Columbia river, sheet No. 1—3d edition	
177.	McArthur's reconnaissance Western Coast, from Monterey to mouth of Columbia river, sheet No. 2—3d edition	
178.	McArthur's reconnaissance Western Coast, from Monterey to mouth of Columbia river, sheet No. 3—3d edition	

179. Alden's reconnaissance Western Coast, northern sheet $\frac{1}{1200000}$
180. Point Reyes and Drake's bay, California $\frac{1}{40000}$
181. Geological map of Point Reyes . . . . do $\frac{1}{1500000}$
182. Humboldt bay, (new edition) . . . . . . do $\frac{1}{30000}$
183. Trinidad bay . . . . do $\frac{1}{20000}$
184. Shelter cove, Mendocino city, Crescent City harbors, and Port Orford, or Ewing harbor, California and Oregon $\frac{1}{20000}$
185. Umpquah river, Oregon $\frac{1}{20000}$
186. Mouth of Columbia river—2d edition—Oregon $\frac{1}{40000}$
187. Do . . . . do $\frac{1}{200000}$
188. Entrance to Columbia river, Oregon $\frac{1}{40000}$
189. Tidal diagrams Rincon Point, San Diego and Astoria, California and Oregon
190. Co-tidal lines of the Pacific coast $\frac{1}{100000}$
191. Cape Disappointment, Washington Territory $\frac{1}{10000}$
192. Shoalwater bay—new edition—Washington Territory $\frac{1}{50000}$
193. Alden's reconnaissance Western Coast, from Grey's harbor to Admiralty inlet, Washington Territory $\frac{1}{200000}$
194. Grenville harbor, Washington Territory $\frac{1}{10000}$
195. Cape Flattery and Nèe-ah harbor, Washington Territory $\frac{1}{40000}$
196. False Dungeness, Washington Territory $\frac{1}{10000}$
197. New Dungeness . . . . do $\frac{1}{40000}$
198. Canal de Haro and Strait of Rosario and approaches, Washington Territory $\frac{1}{100000}$ & $\frac{1}{1000000}$
199. Port Townshend—new edition—Washington Territory $\frac{1}{10000}$
200. Duwamish bay and Seattle harbor . . . . do $\frac{1}{10000}$
201. Smith's or Blunt's island . . . . do $\frac{1}{10000}$
202. Port Ludlow . . . . do $\frac{1}{10000}$
203. Port Gamble . . . . do $\frac{1}{10000}$
204. Olympia harbor . . . . do $\frac{1}{10000}$
205. Steilacoom harbor . . . . do $\frac{1}{10000}$
206. Bellingham bay . . . . do $\frac{1}{40000}$
207. Blakely harbor . . . . do $\frac{1}{10000}$
208. Semi-ah-moo bay . . . . do $\frac{1}{50000}$
209. Base apparatus
210. Self-registering tide-gauge
211. Craven's current indicator
212. Craven's specimen box for deep-sea soundings
213. Mitchell's sea-coast tide-gauge
214. Figures to illustrate Appendix No. 33, 1854
215. Diagrams of secular variation in magnetic declination, 1855
216. Lines of equal magnetic declination $\frac{1}{15000000}$
217. Boutelle's scaffold for stations, and Farley's signal
218. Boutelle's apparatus for measuring preliminary bases
219. Diagrams illustrating earthquake waves at San Diego and San Francisco

220. Diagrams of secular variation in magnetic declination, 1856 ....
221. Sands's gas-pipe tripod ....
222. Sands's specimen box for deep-sea soundings and revolving heliotrope ..
223. Map of magnetic declination ....
224. Map of magnetic dip and intensity ....
225. Apparatus for measuring minor bases ....
226. Polyconic development of sphere ....
227. Diagrams illustrating telegraphic methods for difference of longitude ..
228. Diagrams showing injury to boilers of steamer Hetzel ....
229. Project limits for charts, $\frac{1}{400000}$ and $\frac{1}{1200000}$ ....
230. Diagrams of winds of the Western Coast ....
231. Diagrams illustrating loss of magnetism ....
232. Apparatus for measuring preliminary base lines ....
233. Trenchard's tide-gauge ....
234. Mitchell's tide-gauge ....
235. Diagrams illustrating the descent of sounding weight and line in deep-sea soundings ....
236. Project limits for finished maps, $\frac{1}{10000}$, on Atlantic and Gulf coasts ....
237. Three sketches illustrating the Superintendent's paper on currents of Sandy Hook ....
238. Diagrams of magnetical and meteorological observations at Girard College, Philadelphia, in 1840, '41, '42, '43, '44, and '45 ....
239. Diagrams of observations for temperature, wind, and atmospheric pressure, made by Dr. E. K. Kane, U. S. N., at Van Rensselaer harbor in 1853 and 1855 ....
240–259. Progress sketches ....

Report of Mr. George Mathiot, in charge of the Electrotype Division.

U. S. COAST SURVEY OFFICE, *September* 17, 1859.

I respectfully present the following report of the operations of this division since October 1, 1858.

By the electrotype process we have made eighty-seven plates, of this number fifty were in basso, and thirty-three in alto. I append tables of the plates. We have also made *four* plates for other departments of the government.

During the year the experiments for employing photography in the production of the charts of the survey have been zealously prosecuted, and I am now enabled to decisively say that the photographic method of reduction, is now in successful operation in the office, and I doubt not that before long it will prove far preferable to all other methods for delineation and accuracy, and has incomparably the advantage in economy and rapidity of execution.

I have sought to make use of the photograph in the *construction* of our charts. I emphasize *construction* in order that I may direct attention to the true object of my labors. That facility, which the photograph offers for *copying*, and its almost universal employment for this purpose,

causes the idea to be very generally entertained that we are endeavoring to multiply copies of our charts by photography. Such, however, would be to employ photography for the multiplication or publication of the charts, instead of their *construction*. But, the latter being the true purpose, and the construction of the chart being an operation founded on the methods and purposes of every department of the survey, it will be seen that the proposition to employ photography in making the charts involves no trifling considerations, and prospectively may affect every branch of the survey.

That facility which the camera offers for producing reduced copies of drawings is the element which I have sought to introduce; of the many ways in which this might be done, the following is the method which has been chosen, after the experience of the multitude of experiments I have made for the purpose during the last five years.

It must be borne in mind that a small scale chart is not merely a diminished picture of a chart constructed on a large scale; that the same things are not found in both charts; that the same things are represented differently on the different scales, and that numerous large scale charts combine in the composition of the small scales; and, lastly, that the configurations in the large charts not only change their *size*, but alter also their shape in entering the reduced charts, and this according to the part the object occupies in the reduced scale.

The elements of the charts are hydrographic and topographic sheets, constructed on shipboard by the hydrographer, and on the plane-table in the field by the engineer; these sheets become distorted by the hygrometric action of the paper, and hence are not true maps, and require the hand of man for their rectification; but as the error is only that of a variety of scales on the same sheet, the rectification does not affect the value of the sheet for its data, and can always be made in its reduction to the smaller scales. This is effected in the photographic method which has been adopted, in the following manner:

On a piece of transparent vellum the latitude and longitude lines of the sheet are laid down anew on the same scale as the sheet, but in a form corresponding to that which the area will form in the reduction; on this projection the squares of the minutes of latitude and longitude will not *perceptibly* differ from the squares on the sheets; the plan is, then, simply to lay the transparent vellum on the sheet, so as to make the minute lines for a square on the vellum coincide with those on the sheet; then with a pen trace the geographical delineations on the sheet upon the vellum, and omitting all such parts as are not desired to appear on the reduced chart; in this way the sheet is copied square by square, and all errors of shrinkage rectified, a selection of the desired parts made, and prominent objects made to retain their conspicuousness in the reduction, by increasing their size. In this operation both the judgment of the topographer and the skill of the draughtsman are required, and here is also a great occasion opened for gaining knowledge by experience. What objects to trace and what to omit, and how to trace them, are matters not easily determined; experience, judgment, deliberation, and consultation of the most able topographers and engineers of the survey will be required to decide this.

The work being transferred from the sheet to the vellum, the next operation is to produce the reduced photographic copy; for this purpose it is put up against a white board, and the camera placed at such distance as will insure the required reduction; a "collodion negative" is then made of it, and from this "negative" a paper photograph is produced, which is a reduced copy of the tracing. The photograph is then placed in the hands of the engraver, who transfers it to the copper plate; sheet after sheet being thus reduced and transferred to

the copper by their latitude and longitude lines, the finished chart at length appears in the print from the engraved plate.

Although the method here described is now in successful practice, there still remains an enormous mass of matter, relative to the conventionalities of the charts and their different scales, yet to be decided, and it is easy to foresee that even years will not suffice to wholly determine these points.

By the method I have described, I have, during the past year, constructed four charts of the survey, as follows: San Pablo bay, which I announced in my last annual report as having been successfully reduced from $\frac{1}{50000}$ to $\frac{1}{80000}$, has been twice constructed on $\frac{1}{80000}$ scale from the original sheets of the survey; the selections, however, in the first tracings, not being deemed acceptable after examining the appearance of the reduction, the sheets were again traced, and a second reduction made; this last reduction I have learned from the office is entirely satisfactory, and will be engraved. No. 29 of the eastern series of $\frac{1}{80000}$ charts has been constructed and engraved as far as the survey has been completed. New York bay and harbor, $\frac{1}{80000}$, has also been photographically reduced as far as the original sheets have been verified by the resurvey; the work, as far as done, is, however, already in the hands of the engraver.

I have given but a mere synopsis of the photographic method of constructing the reduced charts. A detailed description would be too voluminous to be given here, and, moreover, the various operations now employed may be superseded by others as experience is gained. I would be pleased, however, to prepare a full account of the photographic method of reducing for publication; and this should at some time be done, as many of the processes are original, and have been acquired by the expenditure of time and money.

I have also, as time would permit during the year, conducted other photographic experiments for the purpose of employing photography in other departments of the survey. Partial success has attended some of the experiments, particularly those I have made in conjunction with Mr. L. F. Pourtales, in charge of the tidal division, for photographing the minute shells found in the specimens of bottoms. In this labor I believe we have trodden an unexplored field, for, so far as I am informed, success has not elswhere attended the efforts to produce enlarged photographs of *opaque* microscopic objects; but there is still room for improvement in our efforts here. Though we have successfully introduced the work of photographing the soundings, other and no small part of my labors have been wholly fruitless thus far, yet persevering industry will ultimately succeed.

During the past year I have been assisted by Mr. D. Hinkle. He has applied himself both in the electrotype and photographic operations. I desire to commend him to the office for his assiduity in the work.

List of plates electrotyped in alto.

Name of chart.	No. made	Name of chart.	No. made.
Annisquam and Ipswich harbors	1	Biloxi bay	1
York river	1	Entrance to Pensacola bay	1
Provincetown harbor	1	Semi-ah-moo bay	1
Patapsco river	2	Pacific coast	1
Sow and Pig's reef	1	Atlantic and Pacific coasts	1
Wachapreague, Machipongo, and Metomkin inlets	1	San Diego bay	1
Atlantic coast	1	Muskeget channel	1
Entrance to San Francisco bay	1	Hatteras inlet	1
St. Simon's sound and Brunswick harbor	1	Romer and Flynn's shoals	1
Frying Pan shoals and entrance to Cape Fear river	1	Wimble shoals	1
Gulf Stream sketch	1	Eggemoggin Reach	1
Rockport harbor	1	Kennebec river	1
Entrance to Brazos river	1	Port Gamble	1
Port Townshend	1	Atchafalaya bay	1
Wood's Hole	1	Charleston harbor	1
York river, upper part	1	Boston harbor, scale $\frac{1}{175000}$	1

List of plates electrotyped in basso.

Name of chart.	No. made.	Name of chart.	No. made.
Chesapeake bay, sheet No. 1	1	Sow and Pig's reef	1
San Diego bay	2	Cape Fear river, lower part	1
Western coast, sheet No. 1	1	St. Simon's sound and Brunswick harbor	1
Western coast, sheet No. 3	1	Entrance to Pensacola bay	1
Harbor of Pass Christian	1	Gulf Stream sketch	1
Middle part of the southern coast of Long Island	2	Western part of southern coast of Long Island	2
Canal de Haro and Rosario Strait	1	Atlantic and Pacific coasts	1
Boston harbor	2	Biloxi bay	1
Provincetown harbor	3	Semi-ah-moo bay	1
Frying Pan shoals and entrance to Cape Fear river	2	Hatteras inlet	1
York river	1	Romer and Flynn's shoals	1
Annisquam and Ipswich harbors	4	Wimble shoals	1
Eastern part of Long Island sound	1	Eggemoggin Reach	1
Patapsco river	2	Frying Pan shoals	1
Atlantic coast	2	Kennebec river	1
Wachapreague, Machipongo, and Metomkin inlets	1	Atchafalaya bay	1
Eastern part of the southern coast of Long Island	1	Rockport harbor	1
Middle part of Long Island sound	1	York river, upper part	1
Entrance to San Francisco bay	1	Wood's Hole	1

Report of Lieut. J. R. Smead, U. S. A., in charge of miscellaneous division.

COAST SURVEY OFFICE,
Washington, November 1, 1859.

The miscellaneous division, consisting of the printing office, the map room, and office for distribution of the maps and charts, and of the Coast Survey Report, was placed under my charge in the latter part of June of this year.

Lieut. James P. Roy, U. S. A., was in charge from the date of the last annual report up to the time of my being ordered to the survey.

The records of the division are kept by Mr. V. E. King, who also has charge of the map room, and distribution of maps, charts, sketches, and Coast Survey Reports, assisted by Mr. F. Holden up to September 1, subsequently by Mr. W. Mertz, the former having resigned his position on that date. Since then I have learned with regret of the sudden death of Mr. Holden from paralysis. In addition to these duties, Mr. King assists in the clerical duties in the office of the assistant in charge. In the miscellaneous division his services are invaluable, from his intimate acquaintance with the details of duty, his constant attendance, and the celerity with which he accomplishes his work.

Mr. W. Mertz, successor to Mr. Holden, in addition to his duties in the map room, backs and stretches paper, and backs and repairs plane-table and other sheets, for use in the drawing division of the office. He has only been employed since September 1, but so far gives entire satisfaction.

In the printing office, Mr. Rutherdale, as printer, with his assistant, Mr. J. Barrett, have been industrious, and very constant in their attendance.

I have caused to be prepared, and herewith respectfully transmit, a statement of Coast Survey maps, charts, and sketches distributed during the year: of these 600 copies of each of thirteen different maps or charts, viz:

Annisquam and Ipswich harbors, Massachusetts.
Boston harbor, Massachusetts.
Plymouth harbor, Massachusetts.
Provincetown harbor, Massachusetts.
Long Island sound—eastern sheet.
Long Island sound—middle sheet.
Long Island sound—western sheet.
Eastern part of southern coast of Long Island.
Middle part of southern coast of Long Island.
Western part of southern coast of Long Island.
York River entrance, Virginia.
Beaufort harbor, North Carolina.
Cape Fear River entrances, North Carolina, have been presented "in conformity with an act of Congress and by direction of the Treasury Department," to different institutions, societies, individuals, &c., both in this country and abroad.

I also transmit a statement of the distribution of Coast Survey Reports, and of the maps, charts, sketches, and miscellaneous matter printed since the date of the last annual report.

List of Coast Survey maps, charts, and sketches distributed during the year, for sale, use of office, and gratuitously.

Names of maps.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Richmond Island harbor		5	18	23
York River harbor	5	2	43	50
Newburyport harbor		3	34	37
Ipswich and Annisquam harbors	11	6	547	564
Gloucester harbor	10	4	29	43
Salem harbor	20	4	27	51
Wellfleet harbor		3	15	18
Boston harbor, $\frac{1}{40000}$	32	9	568	609
Boston harbor, $\frac{1}{175000}$	179		39	218
Plymouth harbor	10	7	578	595
Sea coast of United States from Plymouth, Mass., to Saughkonnet river, Rhode Island				
Provincetown harbor	12	6	562	580
Harbor of Wood's Hole				
Nantucket harbor	5	3	9	17
Edgartown harbor				
Hyannis harbor		3	16	19
Harbors of Holmes's Hole and Tarpaulin Cove		3	11	14
Harbor of New Bedford	15	7	18	40
General coast chart from Gay Head to Cape Henlopen		6	31	37
Long Island sound, eastern sheet	60	2	591	653
Long Island sound, middle sheet	60	2	588	650
Long Island sound, western sheet	60	4	589	653
Fisher's Island sound	20	2	12	34
Harbor of New London	10	4	22	36
Mouth of Connecticut river	10	3	9	22
Harbor of New Haven	5	8	14	27
Harbors of Blackrock and Bridgeport	10	2	9	21
Huntington bay	10	3	10	23
Harbors of Sheffield and Cawkin's island		2	9	11
Harbors of Captain's island, east and west				
Oyster bay or Syosset harbor	10	3	10	23
Hart and City islands and Sachem's Head harbor	10	2	9	21
Hell Gate	20	2	24	46
New York bay and harbor and the environs, $\frac{1}{30000}$		3	5	8
New York bay and harbor and the environs, $\frac{1}{80000}$	105	8	107	220
Eastern part of south coast of Long Island	3	5	570	578
Middle part of south coast of Long Island			526	526
Western part of south coast of Long Island	15	5	567	587
Delaware bay and river, upper sheet	90	7	28	125
Delaware bay and river, middle sheet	90	7	28	125
Delaware bay and river, lower sheet	90	7	28	125
Patapsco river			42	42
Mouth of Chester river		2	9	11
Harbor of Annapolis and Severn river	5	8	32	45

List of Coast Survey maps, &c., distributed—Continued.

Names of maps.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
York River entrance	11	1	549	561
Pasquotank river	....	4	12	16
Beaufort harbor	15	1	574	590
Cape Fear River entrances	....	....	526	526
Cape Fear river from Federal Point to Wilmington	....	....	....	....
Charleston harbor	10	17	77	104
Cat and Ship Island harbors	....	3	15	18
Mobile bay	10	10	75	95
Mobile Bay entrance	10	3	13	26
Galveston entrance	2	3	10	15
Key West harbor and approaches	150	3	54	207
Pensacola harbor	....	....	13	13
San Diego bay	50	1	1	52
Sketches of—Kennebec River entrance	....	....	....	....
Minot's ledge	....	....	8	8
Muskeget channel	2	1	6	9
Nantucket shoals	....	....	....	....
Comparative map of Hudson river	....	....	....	....
Little Egg harbor	10	3	12	25
Delaware and Chesapeake bays	25	....	43	68
Sea-coast of Delaware, Maryland, and part of Virginia	10	1	22	33
Chincoteague inlet	1	1	7	9
Sea-coast of Virginia and entrance to Chesapeake bay	....	....	46	46
Norfolk harbor	....	....	....	....
Hampton Roads	....	....	....	....
Albemarle sound	....	3	38	41
Comparative chart, Beaufort harbor	....	....	....	....
Ocracoke inlet	....	1	5	6
Hatteras and Ocracoke inlets	....	....	....	....
Comparative chart, Cape Fear entrances	....	....	....	....
Frying Pan shoals	....	1	5	6
New river and bar	....	....	4	4
Sea-coast of South Carolina	....	....	....	....
North Edisto	....	....	1	1
St. Helena sound	....	1	....	1
Winyah bay and Georgetown harbor	....	....	35	35
Entrance to Savannah river	....	2	19	21
Savannah city, Front and Back rivers	2	1	7	10
St. Simon's sound and Brunswick harbor	....	....	20	20
Romerly marshes	2	....	4	6
St. Mary's river and Fernandina harbor	....	....	10	10
St. Mary's bar and Fernandina harbor	....	....	....	....
St. Mark's bar	....	1	8	9
St. John's river, from entrance to Brown's creek	10	1	40	51
Comparative chart, St. John's river	....	....	....	....
Legaré anchorage	2	1	4	7
Waccasassa bay	....	....	....	....

List of Coast Survey maps, &c., distributed—Continued.

Names of maps.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Sketches of—Cedar keys	7	2	38	47
Apalachicola river				
St. Andrew's bay	5	3	38	46
Sea-coast of Alabama and Mississippi		3	46	49
St. Louis bay and Shieldsboro' harbor				
Biloxi bay				
Mississippi City harbor				
Grand Island Pass				
Delta of Mississippi		2	11	13
Ship Island shoal			6	6
Galveston bay				
Entrance to Matagorda bay				
San Luis Pass			5	5
Reconnaissance of the western coast of the United States from San Francisco to San Diego	50	11	31	92
Reconnaissance of the western coast of the United States from San Francisco to Umpquah river	50	11	30	91
Reconnaissance of the western coast of the United States from Umpquah river to the boundary	52	10	28	90
Cortez bank				
Prisoner's, Cuyler's, and San Clemente harbors	50		11	61
San Clemente island, southeast end				
Santa Barbara	50		10	60
Anacapa island	52		12	64
San Simeon, Santa Cruz, San Luis Obispo, and Coxo	50		11	61
Santa Cruz and Año Nuevo	52		13	65
San Pedro harbor	50		7	57
Monterey harbor	55		5	60
Map of San Francisco city	557		728	1,285
San Pablo bay				
Humboldt bay	55		6	61
Trinidad bay	55		8	63
Port Orford, Shelter Cove, Mendocino City and Crescent City harbors	52		15	67
Entrance to Umpquah river	50		13	63
Entrance to Columbia river	56		6	62
Shoalwater bay	50		10	60
Reconnaissance from Gray's harbor to Admiralty inlet	51	1	14	66
Cape Flattery and Nee-ah harbor	50		11	61
False Dungeness harbor	50		11	61
Port Townshend	52	2	15	69
Canal de Haro	50	1	27	78
Port Ludlow	52	3	16	71
Port Gamble	52	2	15	69
Blakely harbor	52		15	67
Bellingham bay	52		15	67

List of Coast Survey maps, &c., distributed—Continued.

Names of maps.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Sketches of—Steilacoom harbor	52	....	14	66
Olympia harbor	....	....	....	....
Semi-ah-moo bay	....	....	5	5
Eggemoggin Reach	....	....	3	3
Current chart, Boston harbor	1	....	4	5
Stellwagen's bank	1	....	14	15
Sow and Pig's reef	....	....	3	3
Romer Shoal and Flynn's Knoll	....	....	2	2
Changes in Sandy Hook	1	....	3	4
Wachapreague, Machipongo, and Metomkin inlets	1	....	3	4
Ship and Sand Shoal inlets	1	1	2	4
Cherrystone inlet	1	1	3	5
Pungoteague creek	1	1	3	5
Fishing or Donoho's battery	1	....	12	13
Sea-coast of North Carolina	....	....	....	....
Hatteras shoals	....	....	....	....
Hatteras inlet	....	....	4	4
Wimble shoals	1	....	....	1
Winyah bay and Cape Roman shoals	1	1	3	5
Bull's bay	1	1	4	6
Doboy bar and inlet	10	2	1	13
St. Andrew's shoals	1	....	13	14
Mosquito inlet	1	2	13	15
Cape Canaveral	1	2	4	7
Rebecca shoal	1	1	13	15
Turtle harbor	1	1	14	16
Coffin's Patches	....	1	3	4
Ocilla river	1	2	3	6
Entrance to St. George's sound	1	3	13	17
Horn Island Pass	....	1	4	5
Pascagoula river	1	1	14	16
Pass Christian	1	1	14	16
Entrance to Barrataria bay	1	1	2	4
Pass Fourchon	1	....	4	5
Timballier Bay entrance	1	....	5	6
Vermilion bay and Calcasieu river	1	1	3	5
Aransas Pass	1	2	14	17
Sabine Pass	1	2	14	17
Entrance to Rio Grande river	10	1	4	15
San Pedro anchorage	51	....	10	61
Mare Island straits	20	....	9	29
Point Conception	51	....	10	61
Point Pinos	50	....	10	60
Point Reyes and Drake's bay	51	....	9	60
Cape Hancock	50	....	10	60
Grenville harbor	....	....	1	1

List of Coast Survey maps, &c., distributed—Continued

Names of maps.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Sketch of—Duwamish bay and Seattle harbor	51		11	62
Diagrams to illustrate the secular variation in the magnetic declination				
Lines of equal magnetic declination				
Lines of equal magnetic dip and horizontal intensity				
Map of the world on a policonic development of the sphere				
Total	3,584	306	10,180	14,070

Distribution made during the year of the reports of the United States Coast Survey for the years 1851, 1852, 1853, 1854, 1855, 1856, *and* 1857.

Names of States, &c.	Report of 1851.			Report of 1852.			Report of 1853.			Report of 1854.			Report of 1855.			Report of 1856.			Report of 1857.		
	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.	Individuals.	Institutions.	Total.
Maine	...	...	...	...	...	...	2	...	2	1	...	1	1	...	1	4	...	4	103	95	198
New Hampshire	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	2	68	14	82
Vermont	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	56	4	60
Massachusetts	1	...	1	1	...	1	1	...	1	2	...	2	2	...	2	12	...	12	405	69	474
Rhode Island	1	...	1	...	...	...	...	...	...	1	...	1	...	...	...	2	...	2	52	15	67
Connecticut	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	2	...	2	121	21	142
New York	6	...	6	6	...	6	8	...	8	16	...	16	25	...	25	54	...	54	651	99	750
New Jersey	...	...	...	1	...	1	3	...	3	3	...	3	3	...	3	6	...	6	120	24	144
Pennsylvania	2	...	2	4	2	6	5	2	7	5	2	7	8	2	10	31	2	33	414	97	511
Delaware	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14	6	20
Maryland	...	...	...	1	...	1	1	...	1	4	...	4	6	...	6	14	...	14	184	13	197
District of Columbia	5	...	5	5	...	5	9	...	9	12	...	12	15	...	15	46	...	46	298	...	298
Virginia	...	...	...	1	...	1	2	...	2	2	...	2	4	...	4	12	...	12	165	24	189
North Carolina	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3	...	3	78	9	87
South Carolina	1	...	1	1	...	1	1	...	1	1	...	1	1	...	1	1	...	1	156	16	172
Georgia	1	...	1	2	...	2	2	...	2	1	...	1	1	...	1	3	...	3	76	10	86
Alabama	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	63	12	75
Mississippi	...	...	...	...	...	...	1	...	1	...	...	...	...	...	...	1	...	1	42	5	47
Louisiana	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	2	63	11	74
Ohio	1	...	1	1	...	1	1	...	1	3	...	3	2	...	2	9	...	9	221	62	283
Kentucky	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	91	28	119
Tennessee	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	75	28	103
Indiana	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	112	23	135
Illinois	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	91	35	129
Missouri	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	3	...	3	75	21	96
Arkansas	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	...	12
Michigan	1	...	1	1	...	1	...	...	...	1	...	1	1	...	1	6	...	6	53	15	68
Florida	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	5	...	5	35	3	38
Texas	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	1	...	1	41	1	42
Iowa	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2	...	2	18	13	31
Wisconsin	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...	2	...	2	50	13	63
California	...	...	...	...	...	...	...	...	...	1	...	1	1	...	1	3	...	3	64	13	77
Minnesota	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	8	4	12
Oregon	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10	1	11
Territory of New Mexico	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1
Territory of Washington	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7	...	7
Territory of Kansas	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	...	...	...
Territory of Nebraska	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1
Coast Survey Office and assistants	1	...	1	7	...	7	13	...	13	6	...	6	9	...	9	42	...	42	226	...	226
Officers of the army	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5	...	5	150	...	150
Officers of the navy	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	49	...	49
Executive departments	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	94	...	94
Receivers and registers of land offices	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	88	...	88
Surveyors general of public lands	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12	...	12
Inspectors of steamboats	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9	...	9
Governors of States	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	33	...	33
Collectors of customs, surveyors of ports, &c.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	154	...	154
Revenue bureau	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	30	...	30
Newspapers	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	198	...	198
National Observatory	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	50	...	50
Light-house Board	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	30	...	30
Smithsonian observers	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	286	...	286
Members of Congress	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7	...	7	...	...	...
Foreign	1	...	1	2	...	2	5	...	5	6	...	6	5	...	5	12	...	12	61	...	61
Total	21	...	21	33	2	35	54	2	56	66	2	68	88	2	90	294	2	296	5,517	734	6,251

Aggregate .... 6,817.

Statement of Coast Survey maps, charts, and sketches, printed during the year.

SECTION I.

	No. of impressions.
Sketch A	30
Sketch A bis	30
Boston harbor $\frac{1}{40000}$	183
Boston harbor $\frac{1}{175000}$	237
Provincetown harbor	730
Sea-coast chart from Portland to Race Point	30
Sea-coast chart from Plymouth to Saughkonnet	30
Portsmouth harbor	10
Harbors of Ipswich and Annisquam	705
Plymouth harbor	600
Rockport harbor	30
York River harbor	30

SECTION II.

Hudson river $\triangle^{u}$	60
Long Island sound—eastern sheet	600
Long Island sound—middle sheet	719
Long Island sound—western sheet	821
Eastern part of southern coast of Long Island	619
Middle part of southern coast of Long Island	609
Western part of southern coast of Long Island	601
Sandy Hook diagrams	20

SECTION III.

Sketch C	30
Chesapeake bay, sheet No. 1	30
Chesapeake bay, sheet No. 2	30
Chesapeake bay, sheet No. 3	30
Rappahannock river, sheet No. 5	35
Rappahannock river, sheet No. 6	35
York River entrance	719
Chesapeake bay notes	70
Chesapeake bay titles	30
Patapsco river	90
Delaware bay and river, upper sheet	40
Delaware bay and river, middle sheet	47
Delaware bay and river, lower sheet	40
Delaware and Chesapeake bays	50
York river, from King's creek to West Point	40
Mouth of Chester river	15

Section IV.

	No. of impressions.
Sketch D	30
Beaufort harbor	677
Cape Fear River entrances	650
Pasquotank river	32
Sea-coast chart from Cape Hatteras to Cape Lookout	30

Section V.

Winyah bay and Georgetown harbor	100
St. Simon's sound and Brunswick harbor	40
Sea-coast of South Carolina	30

Section VI.

Sketch F	30
Sketch F bis	30
Entrance to Pensacola bay	150
Legaré anchorage	30
St. Mary's river and Fernandina harbor	40
Florida reefs	45

Section VII.

Sketch G	30

Section VIII.

Sketch H	30
Harbor of Pass Christian	200
Sea-coast of Alabama and Mississippi	30
Atchafalaya bay	30
Mobile bay	5

Section IX.

Sketch I	30
San Luis Pass	50
Sea-coast of Texas	30
Entrance to Brazos river	30

Section X.

Sketch J, middle sheeet	30
Sketch J, lower sheet	30
Entrance to San Francisco bay	12
San Diego bay	171
Monterey bay	35
Prisoner's, Cuyler's, and San Clemente harbors	50
Santa Cruz and Año Nuevo	50
San Pedro harbor	50
Point Pinos	50

	No of impressions.
Point Conception	50
Point Reyes and Drake's bay	75
San Pedro anchorage	75
West Coast reconnaissance, lower sheet	160
SECTION XI.	
Sketch K	30
West Coast reconnaissance, northern sheet	175
Umpquah river	50
Cape Hancock	50
Duwamish bay and Seattle harbor	75
Reconnaissance from Gray's harbor to Admiralty inlet	100
Semi-ah-moo bay	10
Port Townshend	30
Port Gamble	30
MISCELLANEOUS.	
Circular protractors	125
Forms for engraving division	311
Chart of the Pleiades	400
Tidal diagrams	170
Isogonic lines	50
Progress of United States Coast Survey on Atlantic and Gulf coasts	428
Self-registering tide-gauge	40
State map of Virginia	28
Diagrams, descent of sounding weight and lines	20
Current diagrams	100
Proofs from finished and unfinished plates	1,730
	15,194

APPENDIX No. 18.

List of registered topographical sheets received subsequent to No. 680.

Localities.	State.	Scale.	Date.	Topographers.	Register number.
Kennebec river	Maine	1–10,000	1858	R. M. Bache	728
Portland harbor and environs	do	1–10,000	1854–'58	A. W. Longfellow	735
North river	Massachusetts	1–10,000	1858	A. M. Harrison	719
Rondout creek	New York	1–5,000	1858	C. Fendall	727
Esopus creek	do	1–5,000	1858	do	726
Northwestern part of Staten island and Bergen Point	do	1–10,000	1857	H. L. Whiting	751
Bergen Neck, from Centreville to New Jersey railroad	New Jersey	1–10,000	1858	F. W. Dorr	733

APPENDIX No. 18—TOPOGRAPHICAL SHEETS—Continued.

Localities.	State.	Scale.	Date.	Topographers.	Register number.
Passaic river and Newark neck	New Jersey	1-10,000	1858	F. W. Dorr	734
Western part of Newark bay and Staten island sound, from the mouth of Passaic river to Perth Amboy	do	1-10,000	1858	do	729
Chincoteague bay	Virginia	1-20,000	1858	C. Ferguson	723
Chincoteague inlet and bay	do	1-20,000	1858	N. S. Finney	704
York river, from Wormley to Clay Bank	do	1-20,000	1857	J. Seib	685
York river, from Clay Bank to Mount Folly	do	1-20,000	1857-'58	do	686
York river, from Mount Folly to West Point	do	1-20,000	1858	do	722
Richmond city	do	1-5,000	1857-'58	H. Adams	684
Cape Henry	do	1-20,000	1859	J. J. S. Hassler, J. Mechan	753
Back bay	do	1-20,000	1859	do	743
North river	do	1-20,000	1859	J. Mechan	754
Head of Currituck sound	Va. and N. C.	1-20,000	1858	J. J. S. Hassler, J. Mechan	736
Topsail sound, from Water's bay to old Topsail inlet	N. Carolina	1-20,000	1857-'58	John Mechan	711
Cape Fear river, lower part, including New inlet	do	1-10,000	1858	C. P. Bolles	709
Cape Fear river, lower part and approaches	do	1-10,000	1858	do	708
West of Cape Fear river	do	1-10,000	1858	do	725
Dewees and Capers islands	S. Carolina	1-20,000	1856-'57	Lieut. Com'g J. N. Maffitt	681
Morris island and vicinity	do	1-10,000	1858	John Seib	715
Charleston city and vicinity	do	1-10,000	1857-'58	W. S. Edwards	710
Folly island and vicinity	do	1-20,000	1858	John Seib	714
Ossabaw sound and vicinity	Georgia	1-10,000	1858	A. M. Harrison	706
Ogeechee sound and vicinity	do	1-10,000	1858	do	707
Sapelo sound and vicinity	do	1-20,000	1857-'58	A. W. Longfellow	721
Saint Simon's sound	do	1-10,000	1856-'57	do	750
South of St. John's river, from entrance to General E. Hopkins's plantation	Florida	1-10,000	1858	John Mechan	712
South of St. John's river, from General Hopkins's to Diego plains	do	1-10,000	1858	do	713
Key Biscayne, from Shoal Point to Black Point	do	1-20,000	1859	C. T. Iardella	744
Key Biscayne, from Turtle Point to Fender Point	do	1-20,000	1859	do	745
Card's sound, from W. Arsenicker to Jew Point	do	1-20,000	1859	do	746
Barnes's sound	do	1-20,000	1859	do	747
Long island, Mud and Captain keys	do	1-20,000	1857	F. W. Dorr	690
Upper Matecumbe and Windly's island	do	1-20,000	1858	C. T. Iardella	696
Lower Matecumbe and Long key	do	1-20,000	1858	do	694
Duck, Channel, and Conch keys, and part of Long key	do	1-20,000	1857	F. W. Dorr	688
Crawl, Grassy, and Tom's Harbor keys, and part of Flat Deer key	do	1-20,000	1857	do	689
Buchanan and adjacent keys	do	1-20,000	1859	C. T. Iardella	748
Oyster and adjacent keys	do	1-20,000	1859	do	749

APPENDIX No. 18—TOPOGRAPHICAL SHEETS—Continued.

Localities.	State.	Scale.	Date.	Topographers.	Register number.
San Carlos bay and approaches	Florida	1-20,000	1858	F. W. Dorr	693
Charlotte Harbor approaches	...do	1-20,000	1859	F. W. Dorr, C. Ferguson	739
Charlotte Harbor approaches	...do	1-20,000	1859	...do	738
Homosassa river	...do	1-10,000	1857	N. S. Finney	691
Crystal reefs and river	...do	1-20,000	1858	...do	705
From the Waccasassa to the Withlacoochee river	...do	1-20,000	1858	...do	699
Alligator harbor and St George's sound	...do	1-20,000	1858	C. T. Iardella	695
St. George's sound from Royal Bluff, including Dog island	...do	1-20,000	1858	G. D. Wise	697
St Vincent's sound and island	...do	1-20,000	1858	...do	698
Western part of Santa Rosa sound, Pensacola bay	...do	1-10,000	1859	F. H. Gerdes	701
Part of Pensacola, Escambia, and East bays	...do	1-20,000	1858	...do	717
Pensacola bay, west side	...do	1-20,000	1858	...do	700
Part of Matagorda bay, from Trespalacios river to Carankaway bay	Texas	1-20,000	1856	M. Seaton	737
Lavaca bay, from Benado creek to Cox's bay	...do	1-20,000	1858	...do	742
Lavaca bay, from Garcitas bay to Chocolate bay	...do	1 20,000	1858	...do	740
Indianola and environs	...do	1-20,000	1859	W. H. Dennis, M. Seaton	752
From Matagorda Bay entrance to Aransas Pass, (reconnaissance)	...do	1-50,000	1858	S. A. Gilbert	720
From Point Duma to Cañada de Isique	California	1-10,000	1857	W. M. Johnson	703
From Cañada de Isique to Punta Mugù	...do	1-10,000	1857	...do	702
From Santa Clara river to San Buenaventura	...do	1-10,000	1855	...do	683
Crescent City harbor	...do	1-10,000	1859	J. S. Lawson	741
From Punta del Bolsa to Tunitas creek	...do	1-10,000	1854	W. M. Johnson	682
San Francisco city and vicinity	...do	1-10,000	1857-'58	A. F. Rodgers	687
Gulf of Georgia, southern part, from Matia islands to East Point	Wash'n Ter'y.	1-20,000	1858	J. S. Lawson	730
Gulf of Georgia, southern part, from East Point to Deep bay	...do	1-20,000	1858	...do	731
Gulf of Georgia, southern part, from Deep bay to Rocky island	...do	1-20,000	1858	...do	732

APPENDIX No. 19.

List of registered hydrographic sheets received subsequent to No. 632.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Sheepscot river, from Hendrick's Head light to Wiscasset	Maine	1-10,000	1858	Lieut. Comg J. H. Moore	675
Sheepscot river, from Hendrick's Head light to Wiscasset	do	1-10,000	1858	do	676
Kennebec river, from Coxe's Head to Bath	do	1-10,000	1857	Lieut. Comg. S. D. Trenchard	639
Casco bay	do	1-40,000	1857-'58	Lieut. Comg W G Temple.	664
From Kennebunk port to Isles of Shoals	do	1-40,000	1858	Lieut. Comg. A. Murray	667
Salem harbor	Massachusetts.	1-5,000	1858	Lieut. Comg. W. G. Temple.	651
Lynn harbor	do	1-10,000	1858	Lieut. Comg. A. Murray	662
Boston harbor	do	1-10,000	1858	Lieut. Comg W. G. Temple.	652
Shirley's Gut, Boston harbor	do	1-5,000	1858	do	618
Shoal off New Haven light-house	Connecticut	1 5,000	1858	do	647
General chart between Gay Head and Cape Henlopen	N. Y., N. J., and Delaware	1-400,000	1859	A. Boschke	670
Harlem river and Spuyten Duyvel creek	New York	1-10,000	1856	Lieut. Comg. T. A. Craven.	646
East river, from south end of Blackwell's island to Harlem river	do	1-5,000	1856	do	645
Off the Battery, New York harbor	do	1-5,000	1859	do	678
Rondout creek	do	1-5,000	1858	Lieut. Comg. A. Murray	665
Esopus creek	do	1-5,000	1858	do	666
Nanticoke river and Fishing bay	Maryland	1-20,000	1858	Com. W. T. Muse	673
Patuxent river	do	1-20,000	1857	do	641
St. Mary's river, from Point Lookout to Ford's Landing	do	1-20,000	1857	do	640
James river, from Little Brandon to Wyanoke Wharf, (reconnaissance)	Virginia	1-10,000	1857	Lieut. Comg. J. N. Maffitt	634
Off shore, from Cape Henry to Cape Hatteras	Va. and N. C.	1-200,000	1859	Lieut. Comg. A. Murray	674
Pamplico sound	N Carolina	1-40,000	1858	Com. W. T. Muse	672
Pamplico sound	do	1-20,000	1857	do	661
From Flagstaff to New River inlet	do	1-40,000	1858-'59	Lieut. Comg. A. Murray	644
New inlet, northern entrance to Cape Fear river	do	1-10,000	1858	Lieut. Comg. T. B. Huger	643
Cape Fear bar	do	1-10,000	1858	do	642
Deep-sea soundings between Winyah bay and Amelia island	S. C., Ga., and Florida	1-300,000	1858	do	653
Bull's bay	S. Carolina	1-20,000	1859	Lieut. Comg. J. P. Bankhead	683
From Charleston to Savannah	do	1-40,000	1853-'57	Lieut. Comg. J. N. Maffitt	649
Chechessee and Colleton rivers	do	1-10,000	1859	Lieut Comg C. N. Fauntleroy	679
Port Royal entrance	do	1-20,000	1859	do	677
Beaufort river, (reconnaissance)	do	1-10,000	1855	Lieut. Comg. J. N. Maffitt	633

APPENDIX No. 19—HYDROGRAPHIC SHEETS—Continued.

Localities.	State.	Scale.	Date.	Hydrographers.	Register number.
Sapelo sound	Georgia	1-10,000	1858	Lieut. Comg. J. H. Moore	659
Sapelo sound and adjacent waters	do	1-10,000	1858	do	660
Florida reefs, from Bahia Honda to Key Vaccas	Florida	1-20,000	1858	Lieut. Comg. W. G. Temple	663
Florida reefs, from American shoal to Sombrero key	do	1-20,000	1857	Lieut. Comg. T. A. Craven	669
Florida reefs, from East Sambo to Loggerhead key	do	1-20,000	1856	do	650
Cedar keys, resurvey of Main and North keys and southwest channels	do	1-10,000	1858–'59	Lieut. Comg. T. B. Huger	668
St. George's sound, East Pass	do	1-20,000	1858	Lieut. Comg. J. K. Duer	655
St. George's sound, West Pass	do	1-20,000	1858	do	654
Rigolets	Louisiana	1-10,000	1859	W. S. Gilbert	671
Off shore, from Timbalier bay to Galveston bar	La. and Texas	1-635,000	1858	Lieut. Comg. J. K. Duer	657
Atchafalaya bay	Louisiana	1-20,000	1858	Com. B. F. Sands	658
Atchafalaya Bay approaches	do	1-20,000	1859	Lieut. Comg. T. B. Huger	680
Atchafalaya bay	do	1-20,000	1859	do	681
Côte Blanche bay, eastern part	do	1-20,000	1859	do	682
Matagorda bay entrance, Pass del Cavallo	Texas	1-20,000	1858	A. Balbach	635
Brazos River bar	do	1-10,000	1858	Lieut. Comg. J. K. Duer	656
San Francisco bay, from Ravenswood to Coyote creek	California	1-10,000	1857–'58	Lieut. Comg. R. M. Cuyler	636
San Francisco bay, Steinbergen and Redwood City creeks	do	1-10,000	1858	do	637
San Francisco bay, Coyote Hill and Union City creeks	do	1-10,000	1858	do	638

APPENDIX No. 20.

List of geographical positions determined by the United States Coast Survey, and continued from reports of 1851, 1853, 1855, *and* 1857.

The present list is a continuation of that published in the annual reports for 1851, 1853, 1855, and 1857, and contains the geographical positions of points determined astronomically and trigonometrically, since the date of the former reports, with the repetition of a few points previously published for convenience of reference. The following explanations will give all the information required for the use of the tables.

For the purposes of the survey, the coast is divided into eleven sections, in all of which the work is carried on simultaneously. The survey being in different stages of progress in the several sections, and new results being added from year to year to those here given, the same divisions have been adopted in the publication.

The several sections are defined as follows:

SECTION I. From Passamaquoddy bay to Point Judith.

SECTION II. From Point Judith to Cape Henlopen.

SECTION III. From Cape Henlopen to Cape Henry.
SECTION IV. From Cape Henry to Cape Fear.
SECTION V. From Cape Fear to St. Mary's river.
SECTION VI. From St. Mary's river to St. Joseph's bay.
SECTION VII. From St. Joseph's bay to Mobile bay.
SECTION VIII. From Mobile bay to Vermilion bay.
SECTION IX. From Vermilion bay to the Rio Grande.
SECTION X. Coast of California, San Diego bay, to 42d parallel.
SECTION XI. Coast of Oregon and Washington Territory, 42d to 49th parallel.

The tables give the latitudes and longitudes of the trigonometrical points in each section, and their relative azimuths or bearings and distances. The manner in which these data have been obtained may be briefly explained here.

In each section a base line of from five to ten miles is measured with all possible accuracy. A series of triangles, deriving the length of their sides from this base, is then established along the coast by the measurement of the angles between the intervisible stations. In this primary series the triangles are made as large as the nature of the country will permit, because the liability to error increases with the number of triangles.

On the bases furnished by the sides of the primary triangles a secondary triangulation is next established, extending along the coast, and over the smaller bays and sounds, and determining a large number of points at distances a few miles apart for the use of the topographical and hydrographical surveys.

The distances between the points thus determined, as given in the tables, are liable to an average error of about one foot in six miles, until a final adjustment between the base lines shall have been made.

In some parts of the survey the base lines for the primary triangulations have not yet been measured, or the connection between the secondary and primary triangulation has not yet been made, in which cases the distances depend on preliminary base lines, measured with great care, and they are liable to an average error of one foot in three miles. This applies to the positions from the Savannah river to Sapelo sound in Section V, to a part of those in Section VI, and to the positions in Sections VII and IX, to a part of those in Section X, and to Section XI.

As on the completion of the primary or main triangulation in each section the several series form one connected chain, the different bases afford verifications of each other, and of the triangulation connecting them. The first four sections are thus connected, the last section and part of the fifth, however, only in a preliminary way.

Observations for latitude and azimuth are made at a number of stations of the primary triangulation in each section. The differences of latitude, longitude, and azimuth between these and other stations are then computed, under the supposition that the earth is a spheroid of revolution of the following dimensions, which are those determined by Bessel, from the reliable measurements made at the time, viz:

Equatorial radius $=$ 6377397.16 metres.
Polar radius $=$ 6356078.96 metres.
Eccentricity $=$ 0.08169683.

It has been found that the differences of latitude and longitude, as computed in this manner from the distance and azimuth between two stations, and which are called geodetic, differ from

those obtained by astronomical observations at the several stations by quantities which are greater than the errors of the observations. Such disagreements are due to local irregularities in the figure and density of the earth, and the error resulting from them in the determinations of latitude and of the meridian plane is designated as station error. It amounts, according to the results obtained at present, to between one and four seconds of arc in the eastern section of the survey, and to about one second and a half in the sections south of the Delaware.

In order to eliminate the influence of station errors on the general result observations are made at a number of stations; the results are referred to a central station by means of the geodetic differences, and the mean of all is used for the computation of the positions given in the tables. The geographical positions must therefore be considered as liable to future changes from the accumulation of new observations, and from the final discussion of all the results obtained.

The *differences of longitude* are obtained, as has been stated, by computation from the distances, latitudes, and azimuths of the triangulation. In adding up the differences from station to station an accumulation of the incidental errors is probable. They are checked, however, by differences of longitude determined by means of the electro-magnetic telegraph in every section where the introduction of the latter makes it practicable.

Seaton station, in Washington city, has been selected as the centre for the telegraphic differences of longitude. The sections at present connected by telegraph are Sections I, II, III, IV, V, and VIII. The first three being also connected by primary triangulation, the check on the geodetic differences of longitude is here obtained, and the agreement is very close. The longitudes from Greenwich in the first five sections depend directly, and in other sections indirectly, upon that of Cambridge observatory, as determined by chronometric differences between Liverpool and Cambridge, and by occultations, eclipses, and moon culminations, observed at various observatories in the United States, and referred to Cambridge by means of telegraphic differences. The following statement shows the result up to the present time.

Longitude of Cambridge, Mass., from Greenwich.

	h.	m.	s.
By moon culminations observed at Cambridge; Hudson, Ohio; Wilkes' observatory; and National observatory	4	44	28.4
By eclipses and occultations at Cambridge, Brooklyn, Philadelphia, and Wilkes' observatory	4	44	29.6
By chronometric differences from 1,065 exchanges in 1849, 1851, and 1855	4	44	31.9

The longitude as adopted in former reports, (since 1851,) viz: 4*h.* 44*m.* 29.5*s.*, or 71° 07′ 22.50″, is still retained.

	°	′	″
In Section V the longitudes depend on the telegraphic determinations of Charleston and Savannah, viz: Charleston, Gibbes' observatory	79	56	00.0
Savannah Exchange	81	05	16.85
In Section VI the longitude of Fernandina has been assumed as it resulted from the chronometer exchanges with Savannah, viz:	81	27	42.78
For Cape Florida the following value was retained, viz:	80	09	24.0
Sand Key, (as before)	81	52	43.0

In Sections VII, VIII, and IX the longitudes are counted from some central station in each, for which we have at present the following data, subject to future corrections:

	°	′	″
Section VII. Depot key, Cedar keys	83	02	45
Sections VIII and IX. Depend on Fort Morgan, Mobile Point, west of Greenwich	88	00	25

The longitudes in Sections X and XI are reckoned from Greenwich. They depend on moon culminations observed at San Diego, Point Conception, Point Pinos, Presidio, Telegraph Hill, Port Orford, Cape Disappointment, and Cape Flattery, compared with corresponding observations at Greenwich and American observatories, and on chronometric differences between the same and other stations.

	°	′	″
In Section X the longitude of Presidio observatory, San Francisco, has been adopted	122	26	15.0
The Section XI longitudes depend upon Point Hudson astronomical station	122	44	33.0
And upon Lummi Island astronomical station	122	40	36.9

Explanation of the tables.

The first column on the left contains the name of the several stations or triangulation points. Their general locality is indicated by the heading at the top of the page, by means of which they may be readily found on the sketches accompanying the tables. Sub-headings in the first column indicate the locality more minutely where it is practicable.

The stations are generally either prominent objects of permanence, such as spires, light-houses, beacons, &c., or they are points on prominent hills, capes, and points of land where signals have been erected for the purposes of the survey, and which are marked on the ground. In a small number of cases in the first three sections, but much more frequently in the southern sections, where settlements on the coast are sparse and few permanent objects are to be found, the stations have no other distinguishing mark than the signal erected on the spot, and, after its decay, the mark left in the ground, to designate the station point. The latter generally consists of posts or stones set around the point, while the centre of the station is designated by an earthen cone or glass bottle buried under the surface of the ground, and marked on the top by a stone or post. Where the station is on a rock, a copper bolt or a hole filled with lead or sulphur will be found to designate the exact spot.

The sketches showing the configuration of the land, as well as the relative positions of the stations, no great difficulty will be experienced in finding the latter, when desired for local surveys or reference. In any case where minute descriptions of particular points are required they can be had by application addressed to the Coast Survey Office.

The second and third columns contain the latitudes and longitudes of the stations named.

The fourth column contains the azimuth of the line joining the station named in the first column with that named in the fifth; that is to say, the angle which that line makes with the meridian of the former station, reckoned from south around by west through the whole circle.

The sixth column gives the back azimuth of the same line, or the angle which it makes with the meridian of the latter station, reckoned as before; the difference between the azimuths in

the fourth and those in the sixth columns being 180° less the inclination of the meridians at the two stations.

The seventh, eighth, and ninth columns give the distances, in metres, yards, and miles, between the stations named in the first and fifth columns. The relation of the metre to the yard, used in obtaining these results, is:

1 metre = 1.0935696 yard, or 39.368505 United States standard inches.

For each station the azimuths and distances to two other stations are given. In every case the lines so given have actually been observed.

In each section the stations of the primary triangulation are distinguished by being printed in small capitals.

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section I.—Vicinity of Sheepscut River. Sketch No. 2.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Southport Ledge	43 48 56.65	69 38 57.06	333 40 38	Damiscove	153 42 22	7608.3	8320.2	4.73
			296 03 29	White Island	116 06 51	7250.8	7929.2	4.50
Mount Pisgah	43 51 06.89	69 36 51.05	35 01 11	Southport Ledge	214 59 44	4906.9	5366.0	3.05
			332 50 37	White Island	152 52 31	8099.2	8857.0	5.03
Griffith's Head	43 46 55.68	69 42 57.59	197 06 36	Bartoe	17 08 31	12653.2	13837.2	7.86
			289 23 30	Damiscove	109 28 01	9280.3	10148.7	5 77
Cushman	43 58 42.54	69 40 25.04	294 57 35	Edgecombe	115 00 41	6593.8	7210.8	4.10
			358 07 45	Bartoe	178 07 55	9728.3	10638.6	6.04
Haggett, (1)	43 59 44.31	69 36 18.62	354 06 35	Edgecombe	174 06 50	4717.0	5158.4	2.93
			70 52 16	Cushman	250 49 25	5812.5	6356.4	3.61
Neguassett	43 57 39.59	69 44 57.25	320 34 41	Bartoe	140 38 00	10066.9	11008.8	6.25
			252 12 57	Cushman	72 16 06	6370.9	6967.0	3.96
Square Barn, centre	43 59 42.17	69 37 46.84	332 04 58	Edgecombe	152 06 14	5234.6	5724.4	3.25
			62 26 32	Cushman	242 24 42	3976.8	4348.9	2.47
Cottage, white chimney	43 59 12.56	69 41 05.27	298 20 53	Edgecombe	118 24 27	7811.4	8542.3	4.85
			261 15 11	Haggett, (1)	81 18 30	6461.2	7065.8	4.01
Wiscasset, brown spire	44 00 17.72	69 39 41.42	318 49 10	Edgecombe	138 51 46	7602.1	8313.4	4.72
			18 18 17	Cushman	198 17 47	3094.9	3384.5	1.92
Yellow House, chimney	44 02 05.82	69 39 33.95	331 53 16	Edgecombe	151 55 47	10269.0	11229.9	6.38
			10 17 12	Cushman	190 16 37	6376.5	6973.1	3.96
Dunham's Hill	44 00 46.48	69 37 25.18	46 20 52	Cushman	226 18 47	5539.6	6057.9	3.44
			322 17 29	Haggett, (1)	142 18 15	2424.6	2651.5	1.51
Stone Pile	43 59 17.73	69 37 43.73	73 11 48	Cushman	253 09 56	3755.1	4106.5	2.33
			246 35 46	Haggett, (1)	66 36 45	2066.2	2259.5	1.28
Haggett, (2)	43 58 24.03	69 36 04.77	355 28 04	Edgecombe	175 28 09	2221.1	2428.9	1.38
			95 38 19	Cushman	275 35 18	5828.5	6373.9	3.62
Breakheart Hill	43 57 34.89	69 38 13.98	282 51 06	Edgecombe	102 52 41	3135.2	3428.6	1.95
			212 45 59	Haggett, (1)	32 47 19	4749.7	5194.1	2.95
Mathew's Hill	43 56 57.36	69 37 46.80	259 22 22	Edgecombe	89 23 38	2492.4	2725.6	1.55
			200 52 28	Haggett, (1).	20 53 29	5513.6	6029.5	3.42
Allen's Flag	43 56 58.10	69 39 24.94	264 35 48	Edgecombe	84 38 12	4658.6	5094.5	2.89
			157 25 42	Cushman	337 25 00	3489.7	3816.2	2.17
One Story House, chimney in centre.	43 58 28.68	69 36 01.51	357 30 39	Edgecombe	177 30 42	2360.5	2581.4	1.47
			170 43 16	Haggett, (1)	350 43 04	2364.8	2586.1	1.47
Parson's Hill	43 56 11.73	69 40 20.37	357 35 24	Bartoe	177 35 31	5072.7	5547.3	3.15
			252 20 16	Edgecombe	72 23 19	6164.5	6741.3	3.83
Greenleaf's Hill	43 55 24.38	69 41 02.72	17 30 58	Parker's Island	197 29 08	11742.5	12841.2	7.30
			342 11 13	Bartoe	162 11 49	3788.3	4142.8	2.35
Red and White Flag, near school house.	43 54 25.02	69 42 01.01	13 24 08	Parker's Island	193 22 59	9629.1	10530.1	5.98
			305 48 32	Bartoe	125 49 48	3033.0	3316.8	1.88
Lewis Hill	43 54 21.69	69 38 29.08	53 37 26	Bartoe	233 36 16	2819.5	3083.3	1.75
			162 12 25	Cushman	342 11 05	8455.5	9246.7	5.25
Davis Signal	43 52 23.41	69 42 42.39	13 06 29	Parker's Island	193 05 48	5764.1	6303.4	3.58
			239 40 29	Bartoe	59 42 14	3919.6	4286.4	2.43
Tall Hemlock, Westport island.	43 53 28.61	69 42 16.48	13 53 34	Parker's Island	193 52 36	7856.0	8591.1	4.88
			270 40 35	Bartoe	90 42 02	2805.4	3067.9	1.74
Black and Red Flag, southwest part of Westport island.	43 51 31.84	69 42 44.28	17 27 32	Parker's Island	197 26 53	4216.7	4611.2	2.62
			223 48 29	Bartoe	43 50 25	4947.9	5410.9	3.07
Campbell's Ledge	43 51 36.97	69 44 03.93	352 59 13	Parker's Island	172 59 29	4212.8	4607.0	2.62
			236 44 09	Bartoe	56 46 51	6223.2	6805.5	3.87
McMahan's Island	43 50 35.70	69 42 16.44	262 25 28	Mount Pisgah	82 29 13	7330.8	8016.7	4.55
			304 26 33	Southport Ledge	124 28 51	5401.9	5907.3	3.36
Thirty-Acre Island	43 51 22.11	69 40 26.57	185 11 50	Bartoe	5 12 01	3885.8	4249.4	2.41
			275 33 19	Mount Pisgah	95 35 48	4835.8	5288.3	3.00
Martin House, Southport	43 50 32.56	69 40 00.80	177 38 09	Bartoe	357 38 02	5403.8	5909.4	3.36
			30 34 09	Griffith's Head	210 32 07	7772.1	8499.3	4.83
Townsend Gut, red flag	43 50 49.46	69 39 46.52	173 39 48	Bartoe	353 39 31	4907.6	5366.8	3.05
			262 10 12	Mount Pisgah	82 12 14	3955.7	4325.8	2.46
Hendrick's Head-light	43 49 20.45	69 41 03.59	23 20 42	Seguin Light	203 17 51	13951.8	15257.3	8.67
			90 31 21	Parker's Island	270 29 32	3515.2	3844.1	2.18

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section I.—Vicinity of Sheepscut River. Sketch No. 2.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Boothbay Centre, white spire ...	43 52 29.15	69 37 42.90	118 37 34 335 29 02	Bartoe................. Mount Pisgah..........	298 35 51 155 29 38	3759.6 2789.5	4111.4 3050.5	2.34 1.73
Boothbay Harbor, white spire....	43 51 23.28	69 37 09.64	27 56 51 320 37 10	Southport Ledge....... Mount Pisgah..........	207 55 37 140 37 23	5121.9 654.4	5601.1 715.6	3.18 0.41
Hodgden's House, chimney in centre.	43 51 53.91	69 37 58.99	134 29 07 350 25 09	Bartoe................. Damiscove.............	314 27 36 170 26 13	4123.1 12464.3	4508.9 13630.6	2.56 7.74
Tall Pine, Edgecombe..........	43 57 35.93	69 37 00.20	297 20 22 193 10 48	Edgecombe .... Haggett, (1)...........	117 21 06 13 11 17	1589.7 4068.9	1738.4 4449.6	0.99 2.53
Hunting Island, Cape Newagen..	43 47 02.48	69 39 14.37	43 00 10 311 13 52	Seguin Light........... Damiscove.............	222 56 03 131 15 48	11691.4 5000.4	12785.4 5468.3	7.26 3.11
Lower Mark Island.............	43 47 34.14	69 40 12.93	34 57 48 310 06 54	Seguin Light...... .... Damiscove.............	214 54 22 130 09 31	11627.2 6630.3	12715.1 7250.7	7.22 4.12
Burnt Island Light..............	43 49 29.27	69 38 05.22	308 03 41 49 00 50	White Island.......... Southport Ledge.......	128 06 27 229 00 14	6801.1 1534.7	7437.5 1678.3	4.22 0.95
Squirrel Island..................	43 48 20.05	69 37 27.12	346 32 35 70 36 56	Damiscove............. Griffith's Head.........	166 33 17 250 33 07	5851.4 7832.7	6398.9 8565.6	3.63 4.87
Spruce Point..................	43 49 46.66	69 36 58.40	320 46 50 59 48 27	White Island.......... Southport Ledge	140 48 49 239 47 05	6106.1 3067.8	6677.4 3354.8	3.79 1.90
Red Chimney of House..........	43 48 57.03	69 35 55.66	162 50 53 89 51 09	Mount Pisgah .... Southport Ledge.......	342 50 15 269 49 03	4194.1 4053.5	4586.5 4432.8	2.60 2.52
West Gable end of Barn.........	43 49 12.73	69 35 35.51	154 24 49 83 43 53	Mount Pisgah.......... Southport Ledge.......	334 23 57 263 41 34	3906.2 4530.9	4271.7 4954.9	2.43 2.81
House on Hill, chimney.........	43 49 28.45	69 35 21.99	146 47 20 78 28 49	Mount Pisgah.......... Southport Ledge.......	326 46 18 258 26 20	3631.3 4904.9	3971.1 5363.8	2.26 3.05
Methodist Meeting-house, chimney.	43 50 25.28	69 35 02.59	117 56 24 62 27 13	Mount Pisgah.......... Southport Ledge.......	297 55 09 242 24 31	2741.7 5909.4	2998.2 6462.3	1.70 3.67
Linican's Neck, red flag........	43 50 55.48	69 34 38.74	96 48 32 57 35 27	Mount Pisgah... ...... Southport Ledge.......	276 47 00 237 32 28	2975.6 6837.2	3254.0 7477.0	1.85 4.25
Fisherman's Island, chimney of house.	43 48 41.66	69 38 13.60	202 21 35 296 10 06	Mount Pisgah .... White Island....	22 22 32 116 12 57	4846.4 6175.2	5299.9 6753.0	3.01 3.84
Outer Heron Island.............	43 46 32.90	69 34 44.44	214 47 26 128 10 52	White Island.......... Southport Ledge.......	34 47 53 308 07 57	1518.7 7181.6	1660.8 7853.6	0.94 4.46

Section II.—Vicinity of New York. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
Near East River.	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
St. Ann's Church................	40 41 59.06	73 59 05.23	328 18 00 28 37 47	Mount Prospect........ Brooklyn Pilgrim Ch'ch.	148 18 55 208 37 36	3746.1 794.3	4096.6 868.6	2.33 0.49
Naval Hospital Turret...........	40 41 52.83	73 57 35.49	2 39 23 95 13 32	Mount Prospect......... St. Ann's Church	182 39 19 275 12 33	2998.3 2115.3	3278 8 2313.2	1.86 1.31
Pier 28.....................	40 42 22.36	73 59 37.12	345 25 41 313 49 41	Pilgrim Church .... St. Ann's Church.....	165 25 51 133 50 02	1462.9 1037.6	1599.8 1134.7	0.91 0.64
St. John's Church..............	40 43 13.37	74 00 04.51	12 05 20 328 28 27	Governor's Island, (2).. Mount Prospect	192 05 01 148 30 01	3213.1 6427.1	3513.7 7028.5	2.00 3.99
City Mills	40 42 07.73	73 59 23.38	144 28 06 127 52 47	Pier 28 .... St. Paul's Church.....	324 27 57 307 52 13	554.8 1541.3	606.7 1685.5	0.34 0.96
Pier 37..........................	40 42 27.83	73 59 19.22	68 07 53 339 41 26	Pier 28 .... St. Ann's Church......	248 07 41 159 41 35	452.8 946.0	495.2 1034.5	0.28 0.59
Pier 38....................	40 42 27.98	73 59 17.66	49 12 56 341 53 18	Pier 28 .... St. Ann's Church......	249 12 43 161 53 26	488.6 938.5	534.3 1026.3	0.30 0 58
Pier 40..........................	40 42 28.75	73 59 12.50	349 26 13 7 25 00	St. Ann's Church...... Pilgrim Church	169 26 18 187 24 54	931.9 1626.2	1019.1 1778.4	0.58 1.01
Pier 41..........................	40 42 29.06	73 59 10.72	352 03 56 71 30 41	St. Ann's Church..... Pier 28	172 04 00 251 30 24	934 3 653.2	1021.7 714.3	0.58 0.41
Pier 54....	40 42 32.39	73 58 32.73	82 09 58 36 34 59	Pier 45 .... St. Ann's Church......	262 09 40 216 34 38	655.7 1280.0	717.0 1399.8	0.41 0.79

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Vicinity of New York. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Ferrall	40 43 00.45	73 57 44.24	114 34 38	Holy Redeemer Church.	294 33 58	1583.0	1731.1	0.98
			45 07 15	St. Ann's Church	225 06 22	2682.8	2933.8	1.67
Roberts & Williams	40 42 49 42	73 57 46.13	125 35 30	Holy Redeemer Church.	305 34 51	1715.8	1876.3	1.07
			44 43 53	Brooklyn Gas Company.	224 43 27	1346.2	1472.2	0.84
South Ninth Street Pier	40 42 39.76	73 57 53.08	60 00 51	St. Ann's Church	240 00 04	1955.4	2138.4	1.21
			64 05 54	Brooklyn Gas Company.	244 05 32	871.6	953.2	0.54
East and Water Streets, post	40 42 39.94	73 58 16.41	297 21 16	South Ninth Street Pier.	117 21 31	616.6	674.3	0.38
			19 35 22	Brooklyn Gas Company.	199 35 29	705.0	771.0	0.44
Pier 53	40 42 31.90	73 58 40.12	30 12 19	St. Ann's Church	210 12 03	1171.7	1281.3	0.73
			322 26 30	Brooklyn Gas Company.	142 26 39	542.8	593.6	0.34
Pier 55, Jackson street	40 42 32.55	73 58 30.78	84 43 49	Pier 53	264 43 43	220.0	240.6	0.14
			346 59 26	Brooklyn Gas Company.	166 59 29	447.7	489.6	0.28
Pier 50	40 42 31 32	73 58 46.27	24 05 59	St. Ann's Church	204 05 47	1090.1	1192.1	0.68
			264 06 08	Pier 54	84 06 17	319.4	349.3	0.20
F Street Pier	40 43 57.33	73 57 25.67	186 09 42	Blackwell's Island, (2).	6 09 48	2018.9	2207.8	1.25
			59 18 47	Sevent'nth St. Bulkh'd.	239 18 25	907.9	992.8	0.56
South First Street Pier, or Elys' Pier.	40 42 55.03	73 57 45.12	19 14 03	Peck Slip Ferry	199 13 57	649.1	709.8	0.40
			120 11 49	Holy Redeemer Church.	300 11 10	1641.7	1795.3	1.02
South Fourth Street Pier	40 42 45.65	73 57 46.93	129 00 34	Holy Redeemer Church.	308 59 56	1771.3	1937.0	1.10
			27 54 20	Peck Slip Ferry	207 54 15	366.6	400.9	0.23
South Eleventh Street Pier	40 42 26.13	73 57 52.82	127 33 40	East and Water Sts., post.	307 33 25	698.8	764.2	0.43
			73 14 01	Brooklyn Gas Company.	253 13 39	825.6	902.9	0.51
Ann Street, Williamsburg	40 42 12.58	73 57 51.09	144 51 10	East and Water Sts., post.	324 50 53	1032.4	1129.0	0.64
			174 28 48	South Eleventh St. Pier.	354 28 47	419.8	459.1	0 26
Navy Yard Wall, northwest corner.	40 42 14.29	73 58 23.72	194 02 03	Pier 55, Grand street	14 02 09	884.8	967.6	0.55
			243 16 56	South Eleventh St. Pier.	63 17 16	812.1	888.1	0.50
Pier 59	40 42 50.37	73 58 09.73	273 05 44	Roberts & Williams	93 05 59	554.4	606.3	0 34
			242 32 06	Ferrall	62 32 23	674.0	737.1	0.42
Pier 61	40 42 56.89	73 58 10.22	292 14 16	Roberts & Williams	112 14 32	610.6	667.7	0.38
			259 47 52	Ferrall	79 48 09	619.5	677.5	0.38
Pier 56	40 42 45.48	73 58 12.27	315 22 20	South Ninth Street Pier.	135 22 32	639.9	699.8	0.40
			258 50 36	Roberts & Williams	78 50 53	625.0	683.5	0.39
Pier 57	40 42 46.65	73 58 11.66	21 36 25	Pier 56	201 36 25	38.6	42.2	0.02
			261 55 12	Roberts & Williams	81 55 29	605.0	661.6	0.38
Camphene Works, or South Sixth street.	40 42 41.95	73 57 48.44	50 53 14	Brooklyn Gas Company.	230 52 49	1151.1	1258.8	0.71
			90 29 31	Pier 55, Grand street	270 29 14	613.5	670.9	0.39
South Second Street Pier	40 42 52.24	73 57 45.46	185 18 21	South First Street Pier	5 18 21	86.2	94.3	0.05
			122 52 28	Holy Redeemer Church.	302 51 49	1679.9	1837.1	1.04
K Street Pier	40 43 46.03	73 57 26.01	7 08 33	North Eighth Street Pier	187 08 30	871.9	953.5	0.54
			81 32 33	Sevent'nth St. Bulkh'd.	261 32 12	781.7	854.8	0.48
Pier 71	40 43 28.39	73 58 01.92	293 36 29	North Eighth Street Pier.	113 36 49	801.7	876.7	0.50
			334 17 49	Ferrall	154 18 01	956.6	1046.1	0.59
Franklin	40 43 32.60	73 57 23.29	26 22 22	Ferrall	206 22 08	1106.9	1210.5	0.69
			109 40 44	Sevent'nth St. Bulkh'd.	289 40 21	888.8	972.0	0.55
Pittston Coal Company	40 43 22.67	73 57 26.85	195 15 22	Franklin	15 15 24	317.4	347.1	0.20
			128 47 43	Sevent'nth St. Bulkh'd.	308 47 22	966.5	1056.9	0.60
Eighteenth Street and Avenue B.	40 43 52.38	73 58 16.14	307 37 06	Sevent'nth St. Bulkh'd.	127 37 17	508.9	556.5	0.31
			262 38 40	F Street Pier	82 39 13	1193.8	1305.5	0.74
Thirty-eighth Street Pier	40 44 42.27	73 57 55.10	2 47 48	Sevent'nth St. Bulkh'd.	182 47 45	1851.7	2025.0	1.15
			333 31 42	F Street Pier	153 32 01	1548.6	1693.5	0.96
North Thirteenth Street Pier	40 43 26.10	73 57 18.40	61 56 52	Pittston Coal Company.	241 56 46	224.7	245.7	0.14
			150 14 05	Franklin	330 14 02	231.0	252.6	0.14
Penny Bridge	40 43 21.44	73 57 12.26	96 20 02	Pittston Coal Company.	276 19 52	344.6	376.8	0.21
			143 03 38	Franklin	323 03 31	430.7	471.0	0.27
Empire Works Corner	40 44 06.22	73 58 00.49	357 11 33	Sevent'nth St. Bulkh'd.	177 11 34	738.5	807.6	0.46
			288 33 32	F Street Pier	108 33 55	861.7	942.3	0.53
Fifteenth Street and Avenue B	40 43 45.67	73 58 21.13	209 32 19	Eight'nth St. & Avenue B	29 32 22	237.7	259.9	0.15
			281 17 21	Sevent'nth St. Bulkh'd.	101 17 35	530.6	580.3	0.33
Bellevue Hospital	40 44 18.20	73 58 15.22	340 59 03	Sevent'nth St. Bulkh'd.	160 59 14	1171.2	1280.8	0.73
			298 58 58	F Street Pier	118 59 30	1328.8	1453.1	0.82
Clark's Tavern, northwest corner.	40 44 06.17	73 58 16.08	209 50 20	Twenty-eighth St. Pier.	29 50 26	408.4	446.6	0.25
			282 58 10	F Street Pier	102 58 43	1213.7	1327.3	0.75

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Vicinity of New York. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Hunter's Point Station	40 44 48.36	73 56 52.02	85 46 30	Dutch Ref. Ch., marble steeple.	265 45 10	2878.7	3148.1	1.79
			206 38 22	F Street Pier	26 38 44	1760.3	1925.0	1.09
Terrace, Fifty-first Street Corner.	40 45 10.64	73 57 31.77	23 19 49	Eight'nth St. & Avenue B	203 19 19	2629.1	2875.1	1.63
			305 12 11	Blackwell's Island, (2).	125 12 21	440.2	481.4	0.27
Terrace, Fifty-first Street Mark	40 45 11.17	73 57 31.57	307 11 02	Hunter's Point Station.	127 11 28	1164.6	1273.6	0.72
			356 31 07	F Street Pier	176 31 11	2281.5	2495.0	1.42
Hunter's Point R. W	40 44 42.40	73 57 13.49	29 55 30	Sevent'nth St. Bulkh'd.	209 55 00	2138.5	2338.9	1.33
			11 37 41	F Street Pier	191 37 33	1419.2	1552.0	0.88
East and Water Streets Corner	40 42 40.08	73 58 17.04	297 04 36	South Ninth Street Pier.	117 04 52	631.6	690.7	0.39
			18 20 43	Brooklyn Gas Company.	198 20 37	704.1	770.0	0.44
Montague	40 41 42.03	73 59 34.41	76 45 02	Governor's Island, (2)	256 44 24	1417.5	1550.1	0.88
			177 04 35	Pier 28	357 04 33	1245.4	1361.9	0.77
Pier 1	40 41 59.13	74 00 28.39	292 34 41	Montague	112 35 16	1372.6	1501.0	0.85
			7 30 19	Governor's Island, (2)	187 30 16	859.5	939.9	0.53
Pier 5	40 41 59.09	74 00 18.27	22 21 49	Governor's Island, (2)	202 21 39	920.2	1006.3	0.57
			297 37 13	Pilgrim Church, Brooklyn	117 37 50	1505.8	1646.7	0.93
Pier 6	40 41 59.68	74 00 15.78	86 42 03	Pier 1	266 42 11	296.5	324.2	0.18
			25 09 33	Governor's Island, (2)	205 09 44	960.4	1050.3	0.60
Pier 9	40 42 03.04	74 00 09.04	30 13 35	Governor's Island, (2)	210 13 19	1126.0	1231.4	0.70
			306 16 01	Pilgrim Church	126 16 32	1386.1	1515.7	0.86
Degraw Street	40 41 10.06	74 00 04.05	134 03 13	Governor's Island, (2)	314 02 54	951.2	1040.2	0.59
			202 27 17	Ford's Pier	22 27 28	1035.9	1132.8	0.64
Baltic Street Pier	40 41 20.19	73 59 58.03	112 55 17	Governor's Island, (2)	292 54 54	895.7	979.5	0.56
			149 19 01	Pier 1	329 18 41	1396.4	1527.1	0.87
Sedgwick Street Pier	40 41 13.87	74 00 06.71	226 16 49	Baltic Street Pier	46 16 55	282.0	308.4	0.17
			131 12 00	Governor's Island, (2)	311 11 43	825.6	902.9	0.51
De Forrest's Pier	40 42 06.16	73 59 29.02	28 53 50	Ford's Pier	208 53 38	883.1	965.7	0.55
			114 59 01	Trinity Church, N. Y.	294 58 25	1429.4	1563.1	0.89
Bridge Street Ferry Pier	40 42 17.82	73 58 42.96	267 18 03	Brooklyn Gas Company.	87 18 14	387.2	423.4	0.24
			212 10 35	Pier 55, Jackson street.	32 10 43	536.9	587.1	0.33
Congress Street Pier	40 41 22.96	73 59 56.34	106 56 34	Governor's Island, (2)	286 56 10	903.9	988.5	0.56
			200 59 58	Ford's Pier	21 00 04	599.2	655.3	0.37
Thompson's Pier	40 41 58.63	73 59 31.26	60 04 00	Governor's Island, (2)	240 03 20	1677.3	1834.2	1 04
			123 54 34	Trinity Church, N. Y.	303 53 59	1498.4	1638.6	0.93
Baxter's Pier	40 41 51.22	73 59 38.10	134 30 27	Trinity Church, N. Y.	314 29 57	1518.2	1660.3	0.94
			64 48 02	Governor's Island, (2)	244 47 26	1429.1	1562.8	0.89
Prentice's Pier	40 41 43.85	73 59 43.60	143 33 20	Trinity Church, N. Y.	323 32 54	1605.7	1755.9	1.00
			209 36 16	Baxter's Pier	29 36 17	261.3	285.7	0.16
Pier 11	40 42 05.01	74 00 05.87	31 48 32	Governor's Island, (2)	211 48 14	1216.3	1330.1	0.75
			310 10 22	Pilgrim Church	130 10 51	1365.2	1492.9	0.85
Pier 12	40 42 05.82	74 00 04.58	32 22 33	Governor's Island, (2)	212 22 14	1253.5	1370.8	0.78
			316 00 10	Montague	136 00 30	1019.8	1115.2	0.63
Pier 16	40 42 09.93	73 59 58.00	327 13 07	Montague	147 13 22	1023.3	1119.0	0.64
			34 51 32	Governor's Island, (2)	214 51 09	1444.6	1579.8	0.90
Pier 17	40 42 10.94	73 59 56.61	329 40 51	Montague	149 41 05	1032.6	1129.2	0.64
			35 12 48	Governor's Island, (2)	215 12 24	1488.8	1628.1	0.92
Pier 18	40 42 11.99	73 59 55.28	332 03 51	Montague	152 04 05	1045.7	1143.5	0.65
			279 58 03	City Mills	99 58 24	760.3	831.4	0.47
Pier 19	40 42 13.25	73 59 53.49	283 33 17	City Mills	103 33 37	727.2	795.2	0.45
			335 02 47	Montague	155 02 59	1061.8	1161.1	0.66
Nesmith's Pier	40 42 15.10	73 59 10.33	109 35 40	Pier 28	289 35 23	667.4	729.8	0.41
			207 42 13	Pier 45	27 42 19	501.2	548.1	0.31
Pier 20	40 42 14.31	73 59 51.87	286 52 10	City Mills	106 52 28	699.0	764.4	0.43
			36 17 49	Governor's Island, (2).	216 17 22	1638.2	1791.5	1.02
Pier 23	40 42 17.92	73 59 45.21	37 36 04	Governor's Island, (2)	217 35 33	1807.0	1976.1	1.12
			345 56 09	Montague	165 56 17	1140.9	1247.6	0.71
Haxton	40 42 13.95	73 59 18.23	221 06 31	Pier 45	41 06 43	636.1	695.6	0.39
			326 23 41	St. Ann's Church	146 23 51	551.3	602.9	0.34
Pier 42	40 42 29.42	73 59 07.56	269 15 37	Pier 45	89 15 42	167.9	183.6	0 10
			27 41 38	Haxton	207 41 31	538.8	589.2	0.33
Pier 44	40 42 30.08	73 59 02.78	288 14 27	Pier 45	108 14 29	58.5	64.0	0.04
			79 39 09	Pier 42	259 39 06	114.1	124.8	0.07

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Vicinity of New York. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Pier 4	40 41 58.59	74 00 20.65	19 93 07	Governor's Island, (2)	199 22 59	885.8	968.7	0.55
			254 38 44	Pier 5	74 38 46	58.2	63.6	0 04
Pier 7	40 42 00 94	74 00 12.71	302 57 27	Montague	122 57 52	1071.6	1171.9	0.67
			61 44 45	Pier 6	241 44 43	82.0	89.7	0.05
Pier 8	40 42 01.98	74 00 10.71	29 17 17	Governor's Island, (2)	209 17 02	1077.9	1178.4	0.67
			305 48 33	Montague	125 48 57	1051.1	1149.4	0.65
Catharine Street Ferry	40 42 13.31	73 59 06.81	123 42 24	Nesmith's Pier	303 42 22	99.4	108.7	0.06
			196 46 09	Pier 45	16 46 13	521.0	570.2	0.32
Atlantic Stores, northwest corner	40 41 08.00	74 00 10.58	208 16 41	Ford's Pier	28 16 56	1159.0	1267.4	0.72
			165 09 01	Pier 1	345 08 49	1631.3	1783.9	1.01
Pier 10, 1856	40 42 04.15	74 00 07.48	30 55 03	Governor's Island, (2)	210 54 46	1173.9	1283.7	0.73
			311 17 42	Montague	131 18 04	1033.6	1130.3	0.64
Pier 14	40 42 07.76	74 00 01.69	49 09 01	Pier 11	229 08 58	129.7	141.8	0.08
			321 05 02	Montague	141 05 20	1019.6	1115.0	0.63
Clinton Hotel Flag	40 41 27.54	73 59 42.51	165 15 42	Ford's Pier	345 15 39	432.1	472.5	0.27
			132 07 35	Pier 1	312 07 05	1452.3	1588.2	0.90
Long Island Depot	40 41 29.15	73 59 48.60	185 07 16	Ford's Pier	5 07 17	369.9	404 5	0.23
			134 42 23	Pier 1.	314 41 57	1314.4	1437.4	0.82
Coenties and South, southwest corner.	40 42 04.81	74 00 18.35	53 20 20	Pier 4.	233 20 13	293 7	321.2	0 18
			18 42 22	Governor's Island, (2)	198 42 12	1084.7	1186.2	0.67
Old Slip and South, southeast corner.	40 42 09.69	74 00 09.37	316 42 47	Pier 12	136 42 50	164.0	179.3	0.10
			273 13 10	City Mills	93 13 40	1081.5	1182.7	0.67
Second Presbyterian Church, Williamsburg.	40 42 41.16	73 57 21.62	81 11 21	Pier 45	261 10 17	2346.2	2565 7	1.46
			70 10 25	City Mills.	250 09 06	3038.9	3323.2	1.89
Near North River.								
Castle Point	40 44 37.25	74 01 05.33	20 09 26	Jersey City Spire	200 08 52	3507.7	3835.9	2.18
			267 34 13	Dutch Ref. Ch., marble steeple.	87 35 38	3073.9	3361.5	1.91
Cunard's Pier	40 42 50.82	74 01 35.29	192 04 41	Castle Point	12 05 00	3357.1	3671.2	2.09
			329 41 49	Governor's Island, (2)	149 12 29	2848.1	3.14.6	1.77
Pier 52	40 43 57.68	74 00 26.19	45 45 35	Jersey City Spire	225 44 36	2970 0	3247 9	1.85
			123 40 28	West Hoboken	303 39 22	2841.6	3107.5	1.77
New York and Erie Railroad Pier.	40 43 02.14	74 00 34.66	146 37 49	West Hoboken	326 36 49	3937.7	4306.1	2.45
			86 47 39	Jersey City Spire	266 47 01	1381.9	1511.2	0.86
Pier 21	40 42 46.19	74 00 40.68	40 02 26	Bedloe's Island Signal	220 01 22	3602.3	3939.4	2.24
			328 32 51	Trinity Church, N. Y.	148 33 02	739.8	809.0	0.46
Pier 20	40 42 44.54	74 00 40.93	325 56 01	Trinity Church, N. Y.	145 56 12	700.1	765.6	0.43
			170 38 37	Castle Point	350 38 21	3523.1	3852.8	2.19
Pier 45	40 43 37.44	74 00 28.23	47 35 12	Cunard's Pier	227 34 28	2131.5	2330.9	1 32
			154 44 12	Castle Point	334 43 48	2040.1	2231.0	1.27
Pier 23	40 42 48.23	74 00 38.99	93 28 26	Cunard's Pier	273 27 49	1323.6	1447.4	0.82
			169 34 58	Castle Point	349 34 41	3419 2	3739.1	2.12
Pier 28	40 42 55.05	74 00 36.90	84 34 17	Cunard's Pier	264 33 39	1376 3	1505.1	0 85
			188 51 02	Pier 45	8 51 08	1323.2	1447.0	0 82
Pier 33	40 43 04.78	74 00 34.24	165 39 05	Castle Point	345 38 45	2944.0	3219.5	1.83
			73 16 43	Cunard's Pier	253 16 03	1495.8	1635.8	0 93
Pier 8	40 42 29.55	74 00 44.34	172 52 25	Castle Point	352 52 11	3969.3	4340.7	2.47
			118 45 25	Cunard's Pier	298 44 52	1363.7	1491.3	0.85
Pier 6	40 42 27.68	74 00 41.93	121 08 13	Cunard's Pier	301 07 40	1380.7	1509.9	0.86
			173 10 12	Castle Point	353 09 59	4025.0	4401.6	2.50
Pier 4	40 42 23.32	74 00 46.46	126 30 53	Cunard's Pier	306 30 21	1425.6	1559.0	0.88
			173 52 55	Castle Point	353 52 43	4154.5	4543 2	2.58
Pier 13	40 42 35.42	74 00 41.90	171 40 32	Castle Point	351 40 17	3797.9	4153.3	2.36
			110 46 24	Cunard's Pier	290 45 49	1340 0	1465.4	0.83
Pier 35	40 43 08.95	74 00 33.09	69 02 11	Cunard's Pier	249 01 30	1563.1	1709.4	0 97
			164 28 38	Castle Point	344 28 17	2826.8	3091.3	1.76
Pier 39	40 43 20.62	74 00 30.60	160 58 40	Castle Point	340 58 17	2500 3	2734.3	1.55
			58 48 40	Cunard's Pier	238 47 58	1771.3	1940.3	1.10
Pier 49	40 43 47.95	74 00 27.09	149 27 35	Castle Point	329 27 10	1765.9	1931.1	1.10
			42 15 09	Cunard's Pier	222 14 25	2380.2	2602.9	1.48
Pier 46	40 43 40.49	74 00 28.12	153 29 24	Castle Point	333 29 00	1956.5	2139.6	1.21
			45 49 22	Cunard's Pier	225 48 38	2198.0	2403.7	1.36

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

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Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	Metres.	Yards.	Miles.
Pier 47	40 43 42.76	74 00 27.85	152 22 39	Castle Point	332 22 15	1896.8	2074.3	1.18
			44 39 09	Cunard's Pier	224 38 25	2251.8	2462.5	1.40
Pier 55	40 44 03.20	74 00 24.44	137 35 50	Castle Point	317 35 23	1422.7	1555 8	0 88
			177 24 08	Thirteenth Street Pier	357 24 07	892.5	976.0	0.55
Pier 43	40 43 3′.59	74 00 28.54	49 54 21	Cunard's Pier	229 53 38	2047.7	2239 3	1.27
			156 16 03	Castle Point	336 15 38	2145.1	2345.8	1.33
Long Dock, Hoboken	40 44 08.92	74 01 20.24	201 48 12	Castle Point	21 48 22	941.4	1029 5	0.58
			285 16 17	Pier 52	105 16 52	1315.0	1438.0	0.82
Pier 30	40 42 59.30	74 00 35.67	79 24 57	Cunard's Pier	259 24 18	1423.3	1556.5	0.88
			167 01 31	Castle Point	347 01 12	3100.3	3390.4	1.93
Pier 50	40 43 50.89	74 00 26.65	41 00 23	Cunard's Pier	220 59 38	2454.9	2684.6	1 52
			147 35 48	Castle Point	327 35 23	1693.7	1852.2	1.05
Pier 37	40 43 13.56	74 00 32.30	64 37 29	Cunard's Pier	244 36 48	1636.0	1789.1	1.02
			163 17 07	Castle Point	343 16 45	2695 3	2947.5	1.67
Pier 34	40 43 06.28	74 00 33.11	71 54 37	Cunard's Pier	251 53 56	1534.9	1678.5	0.95
			164 55 21	Castle Point	344 55 00	2906.0	3177.9	1.81
Pier 1, lamp	40 42 17.01	74 00 48.80	174 52 32	Castle Point	354 52 21	4343.1	4749.5	2.70
			133 43 06	Cunard's Pier	313 42 36	1509.2	1650.4	0.94
Castle Garden	40 42 09.32	74 00 43.59	126 26 52	Jersey City Spire	306 26 04	2137.3	2337.3	1.33
			54 13 39	Bedloe's Island Signal	234 12 37	2772.2	3031.6	1.72
Pier 2	40 42 19.59	74 00 48.04	130 59 05	Cunard's Pier	310 58 34	1468.8	1606.2	0.91
			174 32 30	Castle Point	354 32 19	4265.2	4664.3	2.65
Pier 3	40 42 21.41	74 00 47.14	174 11 07	Castle Point	354 10 55	4211.4	4605.5	2.62
			128 46 13	Cunard's Pier	308 45 42	1448.9	1584.5	0.90
Pier 14	40 42 36.35	74 00 41.32	171 24 24	Castle Point	351 24 08	3771.6	4124.5	2.34
			109 25 24	Cunard's Pier	289 24 49	1343.0	1468.7	0.83
Fifty-ninth Street Pier, or Ward's Pier.	40 46 18.57	73 59 14.33	155 05 37	Guttenberg Pier	335 05 17	1664.3	1820.0	1.03
			82 43 10	Highwood, (2)	262 42 13	2075.7	2269.9	1.29
Fiftieth Street	40 45 58.78	73 59 31.73	101 53 14	Highwood, (2)	281 52 28	1687.1	1845.0	1.05
			172 08 12	Guttenberg Pier	352 08 04	2140.3	2340.6	1.33
Forty-third Street Pier	40 45 43.67	73 59 45.83	29 55 50	Jersey City Spire	209 54 30	6162.7	6739.3	3.83
			121 36 47	Highwood, (2)	301 36 10	1550.8	1695.9	0.96
Fortieth Street	40 45 32.80	73 59 40.85	178 26 58	Guttenberg Pier	358 26 56	2922.4	3195.8	1.82
			128 38 06	Highwood, (2)	308 37 26	1839.7	2011.8	1.14
Thirty-ninth Street Pier	40 45 34.80	73 59 53.55	133 37 55	Highwood, (2)	313 37 23	1574.5	1721.8	0.98
			29 43 56	Jersey City Spire	209 42 35	5835.3	6381.3	3 62
Twentieth Street Pier	40 44 49.81	74 00 19.60	167 56 10	Highwood, (2)	347 55 55	2530.2	2767.0	1.57
			70 08 02	Castle Point	250 07 32	1140.6	1247.3	0.71
Thirtieth Street Pier	40 45 13.92	74 00 06.06	153 56 20	Highwood, (2)	333 55 56	1926.1	2106.3	1.20
			50 52 49	Castle Point	230 52 10	1792.4	1960.1	1.11
West & Spring, northeast corner Paige's Hotel.	40 43 31 90	74 00 19.87	152 07 01	Castle Point	332 06 31	2280.7	2494.1	1.42
			54 24 30	Cunard's Pier	234 23 41	2176.4	2380.0	1.35
Seventy-first Street Signal	40 46 43.68	73 58 57.80	174 13 32	Russ & Reid's Pier	354 13 25	2526.4	2762.8	1.57
			205 29 16	Station 6	25 29 33	1447.0	1582.4	0.90
Station 5	40 47 00.33	73 58 48.10	23 48 43	Seventy-first St. Signal.	203 48 37	561.0	613.5	0.35
			166 29 21	Russ & Reid's Pier	346 29 08	2057.2	2249.5	1.28
Guttenberg Hill	40 47 34.91	73 59 35.93	12 57 41	Guttenberg Pier	192 57 36	866.8	947.9	0.54
			330 28 35	Seventy-first St Signal	150 29 00	1815.3	1985.2	1.13
Tillietudlum Pier, 1856	40 49 44.10	73 57 57.28	337 11 04	Switch No. 3.	157 11 22	1664.0	1819.7	1.03
			207 03 45	Vreeland, (2)	27 04 00	1215.9	1329.7	0.75
Fort Washington Point, (2)	40 50 59.49	73 56 29.46	62 02 44	Fort Lee, South Pier	242 02 00	1792.3	1960.0	1.11
			82 43 58	Fort Lee, North Pier	262 43 24	1220.9	1335.1	0.76
Lydecker, (2,) 1856	40 52 27.54	73 56 34.19	20 58 00	Fort Lee, North Pier	200 57 34	3073.9	3361.5	1.91
			21 06 34	Tillietudlum Pier, 1856.	201 05 40	5402.9	5908.4	3.36
Lydecker, (3,) 1856	40 52 24.55	73 56 32.17	22 26 46	Fort Lee, North Pier	202 26 26	3006.0	3287.3	1.87
			178 36 17	Ft. Washington Point, (2)	358 36 15	2624.0	2869.5	1.63
Bluff	40 50 14.38	73 56 34.89	110 42 25	Fort Lee, South Pier	290 41 44	1557.2	1702.9	0.97
			64 12 24	Tillietudlum Pier, 1856.	244 11 31	2143.3	2343.8	1 33
Berry's Shanty	40 51 41.59	73 55 50.93	103 37 06	Pettigrove	283 36 27	1423.5	1556.7	0.88
			143 54 14	Lydecker, (3,) 1856	323 53 47	1639.4	1792.8	1.02
Daly	40 49 54.29	73 58 07.82	228 52 35	Ft. Washington Point, (2)	48 53 39	2057.7	2250.2	1.28
			254 06 03	Bluff	74 07 04	2263.8	2475.6	1.41

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	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Hudson River Railroad, (1)	40 51 18.64	73 56 07.27	136 09 50	Pettigrove	316 09 22	1445.5	1580.8	0.90
			208 23 36	Berry's Shanty	28 23 47	804.3	879.6	0.50
Hudson River Railroad, (2)	40 50 37.32	73 56 25.82	16 42 56	Bluff	196 42 50	738.8	807.9	0.46
			112 10 47	Fort Lee, North Pier	292 10 11	1400.6	1531.7	0.87
Hudson River Railroad, (3)	40 49 34.52	73 56 51.91	149 15 53	Fort Lee, South Pier	329 15 23	2070.5	2264.2	1.29
			100 57 25	Tillietudlum Pier, 1856	280 56 42	1559.7	1705.6	0.97
Hudson River Railroad, (4)	40 49 15.79	73 57 09.92	204 25 00	Bluff	24 25 23	1984.1	2169.7	1.23
			128 13 23	Tillietudlum Pier, 1856	308 12 52	1412.3	1544.5	0.88
Carrigan	40 48 33.01	73 57 42.83	141 12 30	Vreeland, (2)	321 12 05	1424.1	1557.3	0.88
			171 12 49	Tillietudlum Pier, 1856	351 12 40	2218.7	2426.3	1.38
High Bridge Farm	40 50 26.90	73 55 13.63	28 01 38	Receiving Reservoir	207 59 56	7795.0	8524.4	4.84
			345 04 24	Cypress Hill	165 06 25	16925.7	18509.4	10.52
Thorp	40 50 32.91	73 55 38.96	290 06 55	Clark	110 15 30	19673.9	21514.8	12.22
			23 28 32	Receiving Reservoir	203 27 06	7704.2	8425.1	4.79
Wolfpit, 1855	40 47 04.92	73 48 55.16	24 04 59	Cypress Hill	204 02 53	11089.5	12127.1	6.89
			87 04 20	Receiving Reservoir	266 58 31	12552.8	13727.4	7.80
Clawson's Point	40 48 16.63	73 50 34.73	313 27 20	Wolfpit, 1855	133 28 25	3215.9	3516.8	2.00
			63 50 14	Latting's Observatory	243 44 57	12668.9	13854.3	7.87
Old Ferry Point, (2)	40 48 15.31	73 49 37.02	335 40 48	Wolfpit, 1855	155 41 15	2382.7	2605.6	1.48
			91 43 44	Clawson's Point	271 43 06	1353.3	1479.9	0.84
Rapalyee, (2)	40 46 12.13	73 52 01.80	249 34 39	Wolfpit, 1855	69 36 41	4669.1	5106.0	2.90
			207 59 00	Clawson's Point	27 59 57	4348.9	4755.8	2.70
Berrian's Island	40 47 06.05	73 53 37.39	270 16 44	Wolfpit, 1855	90 19 48	6616.6	7235.7	4.11
			306 34 08	Rapalyee, (2)	126 35 10	2790.8	3051.9	1.73
College Point, (2)	40 47 35.78	73 50 53.19	31 57 03	Rapalyee, (2)	211 56 18	3040.2	3324.7	1.89
			76 37 09	Berrian's Island	256 35 22	3956.8	4327.0	2.46
Sacred Heart Cross	40 48 55.86	73 56 45.37	280 39 23	Clark	100 48 41	20383.0	22290.2	12.66
			307 11 57	Rapalyee, (2)	127 15 02	8346.7	9127.7	5.19
Hunt's Point	40 48 02.93	73 52 07.56	357 44 10	Rapalyee, (2)	177 44 14	3420.2	3740.2	2.13
			50 12 35	Berrian's Island	230 11 36	2740.6	2997.0	1.70
Randall's Island, 1855	40 47 34.77	73 54 54.66	296 02 51	Berrian's Island	116 03 41	2016.2	2204.9	1.25
			257 28 47	Hunt's Point	77 30 36	4011.8	4387.2	2.49
Woolsey Hill	40 46 57.16	73 54 25.51	62 11 58	Latting's Observatory	242 09 12	6735.9	7366.2	4.18
			149 31 40	Randall's Island, 1855	329 31 21	1346.4	1472.4	0.84
Ward's Island, (1)	40 46 58.59	73 55 10.32	198 13 29	Randall's Island, 1855	18 13 39	1175.2	1285.2	0.73
			272 24 10	Woolsey Hill	92 24 39	1051.4	1149.8	0.65
Sacred Heart Signal	40 49 08.71	73 56 48.06	288 57 59	Wolfpit, (1855)	109 03 08	11723.5	12820.5	7.28
			19 57 38	Latting's Observatory	199 26 25	7660.5	8377.3	4.76
Whitestone Point, (2)	40 47 59.94	73 48 53.16	75 10 19	College Point, (2)	255 09 01	2910.4	3182.7	1.81
			114 46 44	Old Ferry Point, (2)	294 46 15	1132.2	1238.1	0.70
Wilkin's Point	40 47 42.77	73 47 37.14	106 33 06	Whitestone Point, (2)	286 32 16	1859.0	2032.9	1.15
			109 40 13	Old Ferry Point, (2)	289 38 55	2983.9	3263.1	1.85
Fort Schuyler Flag-staff	40 48 15.93	73 47 08.98	89 42 08	Old Ferry Point, (2)	269 40 31	3469.7	3794.3	2.16
			48 39 38	Wolfpit, (1855)	228 38 29	3315.5	3625.7	2.06
Stony Point	40 47 52.61	73 54 15.26	328 16 49	Berrian's Island	148 17 14	1688.5	1846.5	1.05
			59 11 42	Randall's Island, (1855)	239 11 16	1075.3	1175.9	0.67
Lawrence Point	40 47 19.71	73 54 17.85	293 56 23	Berrian's Island	113 56 49	1037.8	1134.9	0.64
			118 18 00	Randall's Island, (1855)	298 17 36	979.8	1071.5	0.61
Port Morris, chimney	40 48 06.69	73 54 01.47	343 12 13	Berrian's Island	163 12 29	1953.5	2136.3	1.21
			272 28 40	Hunt's Point	92 29 54	2672.3	2922.3	1.66
Summerhouse	40 46 36.40	73 55 01.29	232 38 31	Woolsey Hill	52 38 54	1055.0	1153.7	0.65
			162 49 06	Ward's Island, (1)	342 49 00	716.5	783.5	0.44
West Chester Spire	40 50 16.76	73 50 19.67	299 45 40	Clark	119 50 46	12657.4	13841.7	7.87
			9 00 07	Cypress Hill	188 58 56	16242.5	17762.3	10.09
Ursuline Convent	40 48 56.67	73 54 14.51	50 56 27	Receiving Reservoir	230 54 06	6502.5	7110.9	4.04
			282 58 53	Clark	103 06 32	16926.5	18510.3	10.52
India Rubber Factory	40 46 58.93	73 50 56.77	46 34 17	Rapalyee, (2)	226 33 35	2100.1	2296.6	1.30
			192 09 50	Clawson's Point	12 10 04	2451.7	2681.1	1.52
Archer	40 51 23.34	73 54 33.41	296 10 32	Clark	116 18 24	18872.3	20638.2	11.73
			44 38 14	Thorp	224 37 31	2185.5	2390.0	1.36
Fort George	0 51 23.89	73 55 12.04	346 34 39	Cypress Hill	166 36 39	18620.9	20363.2	11.57
			295 03 06	Clark	115 11 23	19695.5	21538.4	12.24

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Vicinity of New York. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station.	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres*	*Yards.*	*Miles.*
Liddle	40 52 45.38	73 54 34.23	19 24 49 359 33 46	Fort George Archer	199 24 24 179 33 47	2664 9 2530.6	2914.2 2767.4	1.65 1.57
Quarry Signal	40 52 40 98	73 54 46.60	14 04 27 352 38 50	Fort George Archer	194 04 10 172 38 59	2451.2 2414.6	2680.6 2640.5	1 52 1.50
Mount Morris	40 48 12.85	73 56 18.59	277 10 42 334 17 02	Clark Cypress Hill	97 19 43 154 19 46	19556.0 13562.0	21385.9 14831.0	12.15 8.43
Lunatic Asylum	40 46 05.99	73 56 18.35	186 23 39 118 31 13	Thorp Receiving Reservoir	6 24 05 298 30 13	8284.5 2441.6	9059.7 2670.1	5.15 1.52
Throg's Neck, (1856)	40 48 30.92	73 47 57.63	292 04 45 78 19 51	Fort Schuyler Flag-staff. Old Ferry Point, (2)	112 05 17 258 18 48	1230.5 2378.6	1345 6 2601.2	0.76 1.48
Fort Schuyler Station	40 48 14.98	73 47 19.20	90 11 42 118 38 23	Old Ferry Point, (2) Throg's Neck, (1856)	270 10 12 298 37 58	3230.1 1026.0	3532.3 1122.1	2.01 0.64
Fort Schuyler, southwest corner	40 48 14.89	73 47 11.51	109 48 57 89 46 01	Thorp Mount Morris	289 43 26 269 40 04	12586.1 12774.8	13763.8 13970.1	7.82 7.94
Watt's Island	40 49 11 58	73 55 49.67	185 42 32 20 31 01	Thorp Mount Morris	5 42 39 200 30 42	2521.1 1933.9	2757.0 2114.8	1.57 1.20
Quarry Hill, (1)	40 48 38.21	73 55 30.80	55 04 15 351 06 46	Mount Morris House of Refuge	235 03 44 171 06 54	1366.0 1949.2	1493 8 2131.6	0.85 1.21
Quarry Hill, (2)	40 48 40.92	73 55 35.36	49 29 04 178 36 05	Mount Morris Thorp	229 28 36 358 36 01	1332.5 3455.1	1457.2 3778.4	0.83 2.15
Prospect Hill	40 47 02.68	73 53 46 39	196 45 40 243 47 02	Mount Morris House of Refuge	16 45 58 63 48 00	2260.2 2310.9	2471.7 2527.1	1.40 1.43
Ward's Island, (2)	40 47 17.60	73 55 33.54	148 13 18 74 55 20	Mount Morris Prospect Hill	328 12 49 254 54 32	2004.6 1768.7	2192.2 1934.2	1.24 1.10
One Hundred and Sixth Street Station.	40 47 16.16	73 55 59.40	11 38 24 165 34 37	Lunatic Asylum Mount Morris	191 36 12 345 34 24	2209.3 1805.0	2416 0 1973.9	1.37 1.12
Astoria, Dutch Reformed church.	40 46 19.82	73 55 30.38	201 27 38 15 19 22	Ward's Island, (1) Mount Prospect	21 27 50 195 17 56	1284.9 11643.1	1405.1 12732.5	0.80 7.23
Astoria, Episcopal church	40 46 19.04	73 55 24.81	15 58 33 102 39 57	Mount Prospect Receiving Reservoir	195 57 04 282 38 22	11655.0 3485.7	12745.6 3811.9	7.24 2.17
Astoria, Presbyterian church	40 46 25.20	73 55 39.59	213 40 23 56 55 06	Ward's Island, (1) Lunatic Asylum	33 40 42 236 54 41	1237.4 1084.9	1353.2 1186.4	0.77 0.67
Horn's Hook	40 46 31.89	73 56 13.18	177 39 57 13 17 32	Mount Morris Hundred and Sixth St	357 39 53 193 17 23	3116.5 1403.8	3408.1 1535.1	1.94 0.87
Near Harlem River.								
Richard	40 51 32.09	73 55 43.31	213 02 28 270 21 05	Fort Independence Archer	33 03 13 99 21 51	2922.2 1659.6	3196.1 1814.9	1 82 1.03
Flat Rock	40 50 38.75	73 57 49 72	17 10 44 293 11 16	Daly Bluff	197 10 32 113 12 05	1435.2 1907.4	1569.5 2085.9	0.89 1.18
Blake	40 52 10.09	73 54 11.31	44 57 19 153 46 31	Fort George Liddle	224 56 29 333 46 16	2013.1 1213.8	2201.5 1327.4	1.25 0.75
J. H. Dyckman.	40 52 01.94	73 54 25.91	171 44 04 233 38 33	Liddle Blake	351 43 59 53 38 43	1354.4 424.3	1481.1 464.0	0.84 0.26
Tiffen	40 52 27.89	73 54 01.40	125 05 26 22 55 39	Liddle Blake	305 05 05 202 55 33	939.2 596.0	1027.1 651.8	0.58 0.37
Cammann	40 51 48.77	73 54 21.87	166 54 19 200 36 28	J H Dyckman Blake	346 53 53 20 36 35	416.9 702.7	455 9 768.4	0.26 0.44
Bridge	40 52 45.21	73 54 17.50	324 47 30 90 50 00	Tiffen Liddle	144 47 41 270 49 49	653 8 391.6	715.0 428.2	0.41 0.24
Bushy Point	40 51 43.13	73 54 40.76	248 30 51 210 56 29	Cammann J. H Dyckman	68 31 03 30 56 39	475.5 676.6	520.0 739.9	0.29 0.42
J. Dyckman	40 52 28.05	73 54 35.99	184 25 29 219 16 13	Liddle Bridge	4 25 30 39 16 25	536.9 684.1	587.1 748.1	0.33 0.42
Pioneer Point	40 51 32.22	73 54 52.41	301 37 51 60 48 12	Archer Fort George	121 38 01 240 47 59	522 7 527.0	571.6 576.3	0.32 0.33
Knoll	40 51 49.62	73 54 55.44	26 06 22 327 30 37	Fort George Archer	206 06 11 147 30 51	883.8 961.0	966.5 1050 9	0.55 0.60
Morris's Pier	40 51 11.86	73 54 59.09	239 31 39 193 59 27	Archer Pioneer Point	59 31 56 13 59 31	697.9 647.3	763.2 707.9	0.43 0.40
Hansel	40 50 42.24	73 55 26.23	207 11 24 214 49 25	Pioneer Point Morris Pier	27 11 46 34 49 43	1733.4 1113.1	1895.6 1217.3	1.08 0.69

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Vicinity of New York. Sketch B, No. 1.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Fordham Dutch Reformed Ch...	40 52 03.25	73 53 42.50	137 01 42	Liddle	317 01 08	1776.4	1942.6	1.10
			121 24 06	J. Dyckman	301 23 31	1467.1	1604.4	0.91
Foundry Signal................	40 52 24.40	73 55 01.75	259 27 44	J Dyckman	79 28 01	613.2	670.6	0.38
			214 44 46	Quarry Signal	34 44 56	623.1	681.4	0.39
Butler's Pier	40 51 31.23	73 54 40.81	224 41 33	Cammann	44 41 45	630.7	689.7	0.39
			180 15 14	Bushy Point	0 15 14	274.3	300.0	0.17
Seaman's Signal................	40 52 14.31	73 54 47.27	181 06 37	Quarry Signal	1 06 37	822.8	899.8	0.51
			132 29 36	Foundry Signal	312 29 27	460.0	503.0	0.29
Finch	40 52 43.63	73 55 01.92	339 12 59	Seaman's Signal.......	159 13 09	966.9	1057.4	0.60
			359 37 24	Foundry Signal........	179 37 24	593.3	648.8	0.37
Foundry Building...............	40 52 27.52	73 54 58.24	170 10 00	Finch	350 09 58	504.3	551.5	0.31
			40 27 57	Foundry Signal.........	220 27 55	126.7	138 5	0.08
Seaman's House................	40 52 12.58	73 54 41.09	171 37 30	Quarry Signal	351 37 26	885.8	968.7	0.55
			353 14 06	Archer	173 14 11	1529.6	1672.7	0.95
Carmansville Spire..............	40 49 48.70	73 56 16.93	0 45 37	Mount Morris...........	180 45 36	2956.7	3233 2	1.84
			330 51 28	Watt's Island	150 51 46	1311.0	1433.7	0.81
Smith	40 49 52.78	73 55 30.97	19 54 14	Mount Morris...........	199 53 43	3277.9	3584.6	2.04
			44 49 44	Sacred Heart Cross	224 48 55	2474.2	2705.7	1.54
Florence...........................	40 49 32.55	73 55 52.78	13 49 28	Mount Morris...........	193 49 11	2531.4	2768.3	1.57
			345 37 06	Quarry Hill, (2)........	165 37 17	1643.7	1797.5	1.02
Campbell..........................	40 49 46.09	73 55 39.90	12 08 11	Watt's Island...........	192 08 05	1088.8	1190.7	0.68
			180 52 04	Thorp....................	0 52 05	1444.0	1579.1	0.90
Hydrographic Point.............	40 49 16.22	73 55 29.29	7 27 14	Quarry Hill, (2)........	187 27 10	1097.9	1200.6	0.68
			73 19 48	Watt's Island...........	253 19 35	498.5	545.1	0.31
Morris	40 48 17.46	73 55 22.32	162 44 12	Quarry Hill, (1)........	342 44 06	670.2	732.9	0.42
			83 51 04	Mount Morris...........	263 50 27	1326 5	1450.6	0.82
Randall's Island, 1856...........	40 47 47.80	73 55 18.20	44 43 11	106th Street Station....	224 42 44	1372.7	1501.1	0.85
			118 38 18	Mount Morris	298 37 39	1612.4	1763.3	1.00
Rhein	40 51 36.73	73 57 09.85	276 25 04	Archer	96 26 46	3686.6	4031 6	2.29
			239 49 04	Liddle....................	59 50 46	4214.6	4609 0	2.62
One hundred and fifty-second Street Pier.	40 49 53.20	73 56 42.64	154 29 24	Fort Lee, North Pier...	334 28 59	2094.5	2290.5	1.30
			162 36 06	Fort Lee Point	342 35 45	2504.0	2738.3	1.55
Hotel, hydrographic flag	40 52 25.21	73 54 13.09	253 10 48	Tiffen....................	73 10 56	286.0	312.8	0.18
			354 54 22	Blake	174 54 23	468.0	511.8	0.29
New York and vicinity.								
Crystal Palace....................	40 45 11.03	73 58 42.75	305 29 03	Cypress Hill............	125 33 21	11382.4	12447.5	7.07
			203 25 39	Receiving Reservoir...	23 26 14	3118.3	3410.0	1.94
Evergreen Cemetery............	40 41 01.06	73 53 42.85	76 00 21	Mount Prospect.........	255 57 45	5773.5	6313.7	3.59
			134 07 27	Highwood, (2).........	314 02 53	13696.9	14978 5	8.51
Paca and Sumpter Avenues.....	40 40 49.28	73 54 22.00	127 15 16	Holy Redeemer Church	307 13 24	7772 3	8499.6	4.83
			77 32 23	Mount Prospect.........	257 31 13	4795.4	5244.1	2.98
Lawrence, (1)....................	40 45 14.03	73 46 59.42	32 02 31	Duryea..................	212 02 11	1333.4	1458.2	0.83
			288 56 38	Valentine, (3)..........	108 58 19	3812.3	4169.0	2.37
Backhaus...........................	40 44 09.01	73 45 17.64	133 31 57	Lawrence, (2).........	313 30 50	3300.6	3609 4	2.05
			110 25 06	Duryea	290 24 40	3302.8	3611.8	2.05
Flushing Roman Catholic Church	40 45 31.50	73 49 15.72	340 19 44	Smith	160 20 34	5388.6	5892 8	3.35
			29 09 53	Cypress Hill	209 08 00	8294.7	9070.8	5.15
Flushing Congregational Church.	40 45 40.25	73 49 11.81	342 08 12	Smith....................	162 09 00	5614.5	6139 8	3.49
			41 52 29	Lutheran Cemetery ...	221 50 09	7550.0	8256.5	4 69
Flushing Episcopal Church Spire.	40 45 35.04	73 49 32.45	336 56 47	Smith	156 57 48	5634.0	6161 2	3.50
			256 19 00	Clark....................	76 23 36	10170.0	11121.6	6.32
Barren Island, (2)	40 35 04.50	73 52 15.26	180 48 59	Cypress Hill	0 49 04	12095 5	13227 3	7.52
			263 06 34	Pavilion Rockaway. .	83 11 20	10414.0	11388.4	6.47
Stoothoff...........................	40 39 29.82	73 50 08.78	313 17 11	Pavilion Rockaway	133 20 35	10117.9	11064.6	6.29
			19 58 29	Barren Island, (2)	199 57 07	8706.3	9520.9	5.41
Canarsie, (2).....................	40 37 44.95	73 52 59.33	231 04 21	Stoothoff	51 06 12	5149 5	5631.3	3.20
			348 10 22	Barren Island, (2)......	168 10 51	5055.9	5529.0	3.14
Rockaway Beach, (2)	40 35 08.24	73 48 09.93	256 07 57	Pavilion Rockaway.....	76 10 03	4708.3	5148.9	2.93
			160 54 47	Stoothoff	340 53 38	8537.9	9336.8	5.30
Thurston's Creek...............	40 38 46.04	73 46 09.54	342 42 23	Pavilion Rockaway.....	162 43 11	5855.1	6403.0	3.64
			22 51 07	Rockaway Beach, (2)..	202 49 49	7289.3	7971.4	4 53

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Vicinity of New York and New York Harbor. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Lotts	40 41 40.16	73 51 45.96	318 37 24	Pavilion Rockaway	138 41 51	14598.8	15964.8	9.07
			78 04 18	Cypress Hill	258 04 04	526.8	576.1	0.33
Furman	40 40 50.84	73 53 16.43	234 23 16	Lotts	54 24 15	2612.0	2856.4	1.62
			308 41 06	Pavilion Rockaway	128 46 33	15087.2	16498.9	9.37
Hopkins	40 40 21.65	73 52 45.17	209 51 17	Lotts	29 51 56	2791.8	3053.0	1.73
			140 49 15	Furman	320 48 55	1161.6	1270.3	0.72
Remsen, flag	40 35 02.52	73 49 09.18	257 39 01	Pavilion Rockaway	77 41 46	6105.3	6676.6	3.79
			163 17 46	Lotts	343 16 04	12805.6	14003.8	7.96
Vanderveer	40 41 51.21	73 50 57.05	323 02 29	Pavilion Rockaway	143 06 25	14137.5	15460.3	8.78
			348 37 21	Remsen, flag	168 38 31	12857.4	14060.5	7.99
Bronson	40 42 30.32	73 48 01.17	340 45 40	Pavilion Rockaway	160 47 41	13246.5	14486.0	8.23
			6 36 21	Remsen, flag	186 35 37	13903.5	15204.4	8.64
Jamaica, Presbyterian church	40 42 15.96	73 47 28.44	79 40 45	Lotts	259 37 57	6145.1	6720.1	3.82
			343 24 14	Pavilion Rockaway	163 25 54	12588.2	13766.1	7.82
Jamaica Dutch Reformed church, (destroyed by fire.)	40 42 06.14	73 47 47.60	81 52 22	Lotts	261 49 47	5652.6	6181.5	3.51
			341 01 00	Pavilion Rockaway	161 02 52	12437.6	13601.4	7.73
Jamaica, Episcopal church	40 42 09.83	73 47 44.98	80 50 21	Lotts	260 47 44	5730.7	6266.9	3.56
			341 27 10	Pavilion Rockaway	161 29 00	12525.0	13697.0	7.78
Flatland, Dutch Reformed church	40 37 24.17	73 55 51.73	281 10 58	Pavilion Rockaway	101 18 05	15726.2	17197.7	9.77
			310 13 50	Barren Island, (2)	130 16 11	6667.1	7290.9	4.14
Rufflepiot, tree	40 35 43.47	73 51 16.06	173 37 28	Cypress Hill	353 36 54	10960.2	11985.7	6.81
			269 42 24	Pavilion Rockaway	89 46 31	8947.0	9784.2	5.56
Carhart's House, flag-staff	40 35 05.97	73 48 35.27	126 42 54	Mount Prospect	306 36 59	15998.0	17494.9	9.94
			157 29 36	Cypress Hill	337 27 18	13045.4	14266.1	8.11
Near Rockaway	40 38 00.61	73 39 29.03	61 23 53	Pavilion Rockaway	241 20 20	8742.6	9560.7	5.43
Gentleman's Hill, 1855	40 34 53.31	73 39 03.41	100 53 10	Pavilion Rockaway	280 49 21	8429.6	9218.4	5.24
			174 03 08	Near Rockaway	354 02 51	5808.0	6351.5	3.61
Hick's Neck, 1855	40 36 41.83	73 42 25.13	239 34 03	Near Rockaway	59 35 58	4799.2	5248.3	2.98
			305 11 37	Gentleman's Hill, 1855	125 13 48	5804.6	6347.7	3.61
Hick's Beach, 1855	40 35 34.57	73 42 32.08	223 40 17	Near Rockaway	43 42 16	6229.1	6811.9	3.87
			184 30 08	Hick's Neck, 1855	4 30 13	2080.9	2275.6	1.29
New York Harbor.								
Fort Tompkins	40 36 13.26	74 03 04.20	286 42 43	Coney Island, east, 1855	106 47 18	10384.9	11356.6	6.45
			237 02 03	Cypress Hill	57 09 37	18361.9	20080.0	11.41
Bluff, (1)	40 24 29.91	73 59 54.01	196 18 48	Coney Island, east, 1855	16 21 19	19486.7	21310.1	12.11
			168 21 18	Fort Tompkins	348 19 15	22150.3	24222.9	13.76
Coney Island, west, 1855	40 34 31.11	74 00 06.06	268 24 32	Coney Island, east, 1855	88 27 11	5759.1	6298.0	3.58
			126 57 59	Fort Tompkins	306 56 03	5241.2	5731.6	3.26
Sandy Hook Signal	40 28 17.05	74 00 03.21	205 56 25	Coney Island, east, 1855	25 59 02	13007.4	14224.5	8.08
			179 40 01	Coney Island, west, 1855	359 39 59	11537.1	12616.6	7.17
Point Comfort, (2)	40 27 19.54	74 07 45.11	260 41 55	Sandy Hook Signal	80 46 55	11024.4	12055.9	6.85
			295 11 17	Bluff, (1)	115 16 22	12274.0	13422.5	7.63
Jones	40 24 01.98	73 59 14 09	222 55 30	Pavilion Rockaway	43 04 47	29639.4	32412.7	18.41
			166 30 49	Fort Tompkins	346 28 20	23197.0	25367.5	14.41
Norton	40 33 38.40	74 05 29.75	334 55 08	Bluff, (1)	154 58 46	18673.2	20420.4	11.60
			262 21 04	Coney Island, east, 1855	82 27 13	13489.2	14751.4	8.38
Prince's Bay	40 30 24.58	74 12 27.86	301 33 47	Bluff, (1)	121 41 56	20858.2	22809.9	12.96
			246 23 29	Coney Island, west, 1855	66 31 31	19038.4	20819.8	11.83
Wilson	40 26 18.87	74 05 08.92	294 19 51	Bluff, (1)	114 23 15	8148.0	8910.4	5.06
			243 07 43	Sandy Hook Signal	63 11 01	8072.3	8827.6	5.01
Conaskonck Point, (2)	40 27 30.60	74 10 24.74	264 21 20	Sandy Hook Signal	84 28 03	14710.0	16086.4	9.14
			212 42 25	Fort Tompkins	32 47 11	19166.1	20959.5	11.91
Seely	40 32 13 66	74 08 54.32	228 03 41	Fort Tompkins	48 07 29	11064.6	12099.9	6.87
			318 17 23	Bluff, (1)	138 23 14	19144.9	20936.3	11.89
Fay	40 31 11.48	74 10 34.79	289 49 54	Sandy Hook Signal	109 56 44	15813.7	17293.4	9.83
			358 00 28	Conaskonck Point, (2)	178 00 35	6816.2	7454.0	4.23
Chapel Hill Light-house Pole	40 23 51.68	74 03 12.67	208 35 53	Sandy Hook Signal	28 37 56	9323.5	10195.9	5.79
			148 53 25	Wilson	238 52 10	5302.7	5798.9	3.29
Chapel Hill Back Light	40 23 51.00	74 03 12.76	.....	Chapel Hill Light-house Pole.	.....	20.7	22.6	0.01

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Vicinity of New York Harbor, Staten Island, and New Jersey. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Carhart	40 25 01.13	74 02 11.66	119 52 10	Wilson	299 50 15	4817.0	5267.7	2.99
			206 35 41	Sandy Hook Signal	26 37 04	6758.3	7390.7	4 20
Seward	40 28 52.90	74 16 13.05	287 09 36	Conaskonck Point, (2)	107 13 22	8588.2	9391.8	5.34
			241 54 28	Prince's Bay	61 56 54	6008.9	6571.1	3.78
Gage	40 30 07.36	74 12 53.34	324 05 11	Conaskonck Point, (2)	144 06 47	5968.5	6527.0	3.71
			63 59 28	Seward	243 57 19	5233.4	5723.1	3.25
Ward's Point	40 29 45.28	74 14 45.97	304 00 01	Conaskonck Point, (2)	124 02 50	7423.6	8118.2	4.61
			51 46 40	Seward	231 45 44	2610.4	2854.7	1.62
Olmstead	40 31 36.94	74 09 14.42	314 53 01	Bluff, (1)	134 59 05	18647.3	20392.1	11.59
			12 18 05	Conaskonck Point, (2)	192 17 19	7775.8	8503.4	4.83
Sandy Hook Light-house	40 27 39.49	73 59 48.56	202 34 42	Coney Island, east, 1855	22 37 10	13932.2	15224.9	8.65
			163 49 03	Fort Tompkins	343 46 56	16501.5	18045.5	10.26
Hilton	40 25 17.19	74 03 09.44	180 20 57	Fort Tompkins	0 21 00	20235 4	22128.8	12.57
			147 43 30	Seely	327 39 46	15198.0	16620.1	9.44
Garrison	40 32 00.16	74 07 43.09	321 27 05	Bluff, (1)	141 32 09	17745.9	19406.4	11.03
			71 34 20	Olmstead	251 33 20	2265.7	2477.7	1.41
Winslow	40 37 16.94	74 05 04.10	242 01 38	Mount Prospect	62 06 26	11771.6	12873.1	7.31
			189 06 51	Bergen Dutch Ref. Ch.	9 07 43	11793.1	12896.6	7 33
Wyckoff's House	40 34 33.98	73 58 03.64	113 27 21	Fort Tompkins	293 24 05	7702.0	8422.7	4.78
			74 16 05	Seely	354 09 02	15906.4	17394.8	9.88
Oceanic House, flag	40 34 45.34	73 58 11.94	111 33 47	Fort Tompkins	291 30 37	7387.3	8078.5	4.59
			7 13 32	Bluff, (1)	187 12 26	19133.1	20923.4	11.89
Spit, double flag	40 33 37.12	73 53 24 17	153 50 22	Mount Prospect	333 47 35	18701.4	14983.4	8.51
			109 29 41	Fort Tompkins	289 23 24	14464.5	15817.9	8.99
Inlet, flag	40 34 12.55	73 51 32.25	176 30 03	Cypress Hill	356 29 40	13722.1	15006.1	8.53
			102 57 09	Fort Tompkins	282 49 39	16690.5	18252.2	10.37
Bath House	40 35 58.97	74 00 00.34	2 50 26	Coney Island, west, 1855	182 50 22	2713.0	2966.9	1.68
			95 49 57	Fort Tompkins	275 47 58	4344.5	4751.0	2.70
Penitentiary	40 39 57.68	73 56 49.45	114 31 30	Mount Prospect	294 30 56	1341.1	1466.6	0.83
			205 30 47	Betts	25 32 32	8744.3	9562.5	5.43
Litchfield	40 39 58.58	73 58 07.02	228 40 33	Mount Prospect	48 40 50	801.1	876.1	0.50
			130 04 42	Bergen, Dutch Ref. Ch'ch	130 04 42	10348.8	11317.1	6.43
Red Hook, chimney	40 40 43.65	74 00 42.33	281 26 37	Mount Prospect	101 28 35	4336.1	4740.7	2.69
			180 01 29	Highwood, (2)	0 01 29	10066.3	11008.2	6.25
Wyckoff, 1853	40 34 33.73	73 58 02.77	113 26 18	Fort Tompkins	293 23 02	7726.4	8449.4	4.80
			11 03 21	Sandy Hook Light	191 02 12	13018.5	14236.6	8.09
Coney Island, east, 1853	40 34 36.33	73 56 01 55	106 46 36	Fort Tompkins	286 42 01	10379.8	11351.0	6.45
			88 24 24	Wyckoff, 1853	268 23 05	2852.2	3119.1	1.77
Coney Island, west, 1853	40 34 30.99	74 00 06.03	126 58 41	Fort Tompkins	306 56 45	5246.4	5737.3	3.26
			268 19 21	Wyckoff, 1853	88 20 41	2899.7	3171.0	1.80
Romer Iron Beacon	40 30 13.30	73 59 35.86	157 11 35	Fort Tompkins	336 08 56	12137.1	13272.8	7.54
			195 14 33	Wyckoff, 1853	195 14 33	8326.1	9105.2	5.17
Romer Stone Beacon	40 30 44.10	74 00 30.13	184 37 54	Coney Island, west, 1853	4 38 06	7020.8	7677.7	4.36
			221 23 49	Coney Island, east, 1853	41 26 44	10780.7	11789.4	6.70
Staten Island and New Jersey.								
Curtis	40 34 43.89	74 04 12.81	273 51 44	Coney Island, west, 1855	93 54 24	5816.3	6360.5	3.61
			210 20 09	Fort Tompkins	30 20 54	3194.1	3493.0	1.98
Seguine's Point, chimney	40 30 36.30	74 11 26.49	64 43 36	Seward	244 40 30	7463.0	8161.3	4.64
			345 44 48	Conaskonck Point, (2)	165 45 28	5909.3	6462.2	3.67
Conover's Beacon	40 25 14.21	74 03 01.39	179 48 41	Fort Tompkins	359 48 39	20327.7	22229.7	12.63
			123 34 23	Wilson	303 33 00	3607.1	3944.6	2.24
Wilson's Beacon, back of Point Comfort.	40 26 35.80	74 07 51.32	200 45 13	Fort Tompkins	20 48 19	19049.3	20831.7	11.84
			171 53 55	Seely	351 53 14	10524.9	11509.7	6.54
Light-house Flag, near Pt. Comfort	40 26 50.75	74 06 56.81	197 29 26	Fort Tompkins	17 31 57	18192.4	19894.7	11.30
			74 45 31	Sandy Hook Signal	254 41 02	10160.6	11045.7	6.28
Morgan, (2)	40 28 08.05	74 15 36.15	278 55 09	Conaskonck Point, (2)	98 58 31	7426.5	8121.4	4.61
			226 27 29	Prince's Bay	46 29 31	6114.7	6686.8	3.80
Morgan, (3)	40 28 05.18	74 15 33.80	278 18 24	Conaskonck Point, (2)	98 21 45	7358.2	8046 7	4.57
			200 02 20	Ward's Point	20 02 51	3286.2	3593.7	2.04
Chestnaquack Point, (2)	40 27 36 88	74 14 42.36	178 46 22	Ward's Point	358 46 20	3961.1	4331.7	2.46
			137 40 31	Seward	317 39 32	3171.8	3468.6	1.97

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Vicinity of Staten Island and New Jersey. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Brown	40 27 07.00	74 13 26.68	199 49 24	Seward	309 47 36	5101.5	5578.8	3.17
			159 04 17	Ward's Point	339 03 26	5226.6	5715.6	3.25
Matayan	40 26 48.87	74 12 18.90	244 25 15	Conaskonck Point, (2)	64 26 29	2981.9	3260.9	1.85
			147 31 22	Ward's Point	327 29 57	6450.0	7053.5	4.01
New Durp Beacon, or Elm Tree Back Light.	40 34 48.08	74 06 53.84	331 26 40	Jones	151 31 [illegible]9	22678.9	24800.9	14.09
			273 04 46	Coney Island, west, 1855	93 09 11	9603.5	10502.1	5.97
Elm Tree Light-house	40 33 45.35	74 05 26.17	259 20 40	Coney Island, west, 1855	79 24 08	7660.1	8376.8	4.76
			133 11 14	New Durp Beacon	313 10 17	2827.3	3091.8	1.76
Elm Tree Light-house, range	40 33 44.54	74 05 25.04	323 06 05	Sandy Hook Signal	143 09 34	12625.2	13806.5	7.84
			335 28 17	Bluff, (1)	155 31 52	18798.9	20557.9	11.68
Bayside Beacon	40 26 50.58	74 06 57.46	164 34 21	Seely	314 33 05	10337.3	11304.6	6.42
			197 31 39	Fort Tompkins	17 34 30	18202.4	19905.6	11.31
Ellis Island, flag-staff	40 41 53.79	74 02 04.29	296 04 54	Mount Prospect	116 07 45	6873.7	7516.9	4.27
			217 41 41	Latting's Observatory	37 43 54	7854.4	8589.3	4.88
Seaman's Retreat	40 37 20.99	74 04 11.49	239 30 17	Mount Prospect	59 34 31	10631.4	11626.2	6.60
			157 05 09	Fiedler	337 04 54	1410.4	1542.4	0.88
Elizabeth Port, Presbyterian Church, white spire.	40 38 49.75	74 11 08.24	284 58 03	Cazet	105 02 03	8858.7	9687.6	5.50
			28 30 24	Miller	208 29 18	5004.2	5472.4	3.11
Bergen Point Church	40 38 49.58	74 07 19.24	258 52 16	Mount Prospect	78 58 33	13830.2	15124.3	8.59
			305 44 49	Cazet	125 46 17	3914.2	4280.4	2.43
Newark, Presbyterian Church	40 44 01.18	74 10 02 26	275 16 43	Bergen, Dutch Ref. Ch'h	95 20 50	8901.9	9734.8	5.53
			329 29 42	Latting's Observatory	149 32 57	13806.0	15097.8	8.58
Newark, Methodist Church	40 44 03.58	74 09 52.60	275 54 09	Bergen, Dutch Ref Ch'ch	95 58 09	8683.5	9496.0	5.59
			261 58 15	Latting's Observatory	82 05 35	15945.1	17437.1	9.91
Centreville Church	40 40 03.23	74 06 33.26	268 10 59	Mount Prospect	88 16 47	12496.4	13665.7	7.76
			335 18 19	Cazet	155 19 17	5017.6	5487.1	3.12
Brighton Spire	40 38 47.28	74 04 46.89	254 41 46	Mount Prospect	74 46 23	10359.2	11328.5	6.43
			10 18 53	Cazet	190 18 42	2253.0	2463.8	1.40
Newark Bay Light, or Passaic Light.	40 41 43.69	74 07 19.23	235 50 48	Bergen, Dutch Ref. Ch'ch	55 53 08	6088.9	6658.6	3.78
			153 43 47	Lentz	333 43 21	2156.6	2358.4	1.34
Newark Bay Beacon	40 43 05.60	74 07 07.97	240 07 42	Bergen, Dutch Ref. Ch'ch	60 09 55	5506.1	6021.3	3.42
			135 54 04	Lentz	315 53 30	1751.7	1915.6	1.09
Robin's Reef Light	40 39 23.85	74 03 36.78	259 06 54	Mount Prospect	79 10 46	8498.7	9293.9	5.28
			198 05 55	Highwood, (2)	18 07 49	13181.2	14414.6	8.19
Kill's Light, Bergen Point	40 38 32.23	74 08 35.84	289 22 52	Cazet	109 25 10	5276.0	5769.7	3.28
			186 08 16	Lentz	6 08 39	7884.3	8622.0	4.90
Long Neck	40 35 07.84	74 11 43.74	191 05 12	Elizabeth Port Hotel	11 05 49	6982.2	7635.5	4.34
			147 39 52	Miller	327 39 09	2895.9	3166.9	1.80
Benedict	40 33 43.63	74 11 52.36	150 22 28	Braisted	330 21 53	2558.8	2798.2	1.59
			160 48 10	Blazing Star	340 47 49	2354.5	2574.8	1.46
Rossville Signal	40 33 23.78	74 12 19 54	167 49 18	Braisted	347 49 01	2964.8	3242.2	1.84
			177 20 06	Blazing Star	357 20 02	2900.3	3171.7	1.80
Decker	40 35 06.25	74 08 23.12	51 32 00	Frost	231 30 26	4343.5	4749.9	2.70
			21 29 45	Cortelyou	201 29 07	3726.1	4074.7	2.31
Wyckoff's Landing, pier	40 34 23.34	74 12 25.62	215 40 10	Long Neck	35 40 37	1689.6	1847.7	1.05
			180 25 07	Blazing Star	0 25 07	1062.1	1161.5	0.66
Wyckoff's Landing, flag	40 34 34.73	74 12 27.51	196 45 43	Elizabethport Hotel	16 46 49	8222.8	8992.2	5.11
			184 12 02	Blazing Star	4 12 03	712.9	779.6	0.41
Turner	40 33 58.08	74 13 35.78	300 33 22	Rossville Signal	120 34 12	2084.0	2279.0	1.29
			212 26 36	Braisted	32 27 08	2178.5	2382.3	1.35
Dissosway	40 33 15.61	74 13 25.00	260 45 58	Rossville Signal	80 46 41	1560.9	1706.9	0.97
			169 01 56	Turner	349 01 49	1334.4	1459.3	0.83
Marsh	40 33 37.62	74 14 50.24	250 11 06	Turner	70 11 54	1862.5	2036.8	1.16
			288 41 09	Dissosway	108 42 04	2118.1	2316.3	1.31
Woodbridge Landing	40 32 43.23	74 14 59.71	187 33 40	Marsh	7 33 46	1692.2	1850.5	1.05
			245 51 37	Dissosway	245 51 37	2142.8	2671.4	1.52
Smoking Point	40 33 18.51	74 13 14.06	157 16 10	Turner	337 15 56	1323.4	1447.2	0.82
			70 50 21	Dissosway	250 50 14	272.5	298.0	0.17
Signal on the Marsh	40 33 38.83	74 13 37.36	318 48 46	Smoking Point	138 49 01	832.8	910.7	0.52
			337 53 11	Dissosway	157 58 19	773.1	845.4	0.48
Tuft's Point	40 33 28.70	74 12 54.54	280 33 07	Rossville Signal	100 33 30	838.0	916.4	0.52
			55 37 07	Smoking Point	235 36 54	556.7	608.8	0.34

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Vicinity of Staten Island and New Jersey. Sketch B, No. 1.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Rossville Wharf	40 33 21.13	74 12 39.85	260 29 47	Rossville Signal	80 30 00	484.7	530.0	0.30
			84 16 06	Smoking Point	264 15 44	809.3	885.0	0.50
High Scaffold	40 34 41.82	74 07 39.87	246 10 21	Frost	66 12 23	4829.1	5281.0	3.00
			93 55 05	Braisted	273 51 46	7221.5	7897.2	4.49
Tappan's Point	40 32 33.13	74 14 15.09	157 24 59	Marsh	337 24 36	2154.2	2355.8	1.34
			199 26 50	Turner	19 27 16	2778.7	3033.7	1.73
Herbert	40 32 02.81	74 15 06.09	188 59 09	Woodbridge Landing	8 59 14	1262.2	1380.3	0.78
			233 08 17	Tappan's Point	53 08 51	1559.1	1705.0	0.97
Ellis	40 32 30.38	74 14 25.78	116 23 18	Woodbridge Landing	296 22 56	891.6	975.0	0.55
			49 31 19	Herbert	229 30 51	1309.7	1432.2	0.81
Wyckoff	40 34 17.45	74 13 53.16	9 06 30	Tappan's Point	189 06 16	3258.6	3563.5	2.02
			28 19 17	Woodbridge Landing	208 18 34	3301.0	3609.9	2.05
Jessup's Cupola	40 32 50.44	74 11 01.77	119 57 14	Turner	299 55 34	4182.9	4574.3	2.60
			192 38 08	Frost	12 38 17	1521.5	1663.9	0.95
Callet's Cupola	40 34 40.71	74 07 41.22	94 12 25	Braisted	274 09 07	7192.2	7865.2	4.47
			66 25 36	Frost	246 23 35	4786.2	5234.0	2.97
Androvetts	40 32 17.48	74 14 14.93	70 07 23	Herbert	250 06 48	1330.7	1455.2	0.83
			127 00 35	Woodbridge Landing	307 00 06	1319.9	1443.4	0.82
Terrill	40 31 24.13	74 15 05.48	215 52 19	Androvetts	35 52 52	2030.7	2220.7	1.26
			177 03 12	Herbert	357 03 10	1194.5	1306.3	0.74
Dubois	40 31 27.60	74 14 17.06	84 37 57	Terrill	264 37 26	1145.2	1252.4	0.71
			132 06 34	Herbert	312 06 01	1619.3	1770.8	1.01
Gage	40 31 03.02	74 14 15.79	177 44 47	Dubois	357 44 46	758.7	829.7	0.47
			119 05 39	Terrill	299 05 07	1338.9	1464.2	0.83
Yellow Hill	40 34 18.02	74 09 23.33	58 30 57	Frost	238 30 02	2326.2	2543.9	1.45
			358 30 16	Cortelyou	178 30 17	1980.4	2165.7	1.23
Woodbridge, white spire	40 33 39.82	74 16 05.95	262 40 43	Fort Hill, (1)	82 45 21	10131.5	11079.5	6.29
			270 15 19	Frost	90 18 46	7491.0	8191.9	4.65
Wynant	40 32 55.28	74 13 58.89	137 13 06	Marsh	317 12 33	1779.4	1945.9	1.11
			75 27 08	Woodbridge Landing	255 26 28	1479.0	1617.4	0.92
Storer	40 33 23.03	74 14 14.88	40 41 07	Woodbridge Landing	220 40 38	1618.8	1770.3	1.01
			8 58 14	Ellis	188 58 07	1643.8	1797.6	1.02
Fire-brick Works	40 30 51.06	74 15 16.06	230 56 41	Dubois	50 57 19	1788.8	1956.2	1.11
			255 25 30	Gage	75 26 09	1466.1	1603.3	0.91
Crizier Signal	40 31 51.69	74 13 46.19	132 34 51	Woodbridge Landing	312 34 03	2350.6	2570.5	1.46
			100 06 37	Herbert	280 05 44	1958.8	2142.1	1.22
Richmond, Episcopal church	40 34 19.79	74 08 32.09	68 18 19	Frost	248 16 51	3432.6	3753.8	2.13
			29 34 15	Cortelyou	209 33 43	2338.7	2557.5	1.45
Richmond Court-house	40 34 12.77	74 08 25.73	72 30 11	Frost	252 28 39	3501.3	3828.9	2.18
			35 39 12	Cortelyou	215 38 36	2237.3	2446.6	1.39
Arent's House	40 30 37.50	74 14 28.14	148 33 03	Terrill	328 32 39	1685.4	1843.1	1.05
			203 21 21	Crizier Signal	23 21 48	2492.0	2725.2	1.55
Springville, Methodist church	40 35 55.78	74 09 28.96	23 38 06	Frost	203 37 15	4617.6	5049.7	2.87
			101 36 41	Miller	281 34 30	4817.2	5267.9	2.99
Perth Amboy, Presbyterian church	40 30 18.09	74 15 37.80	17 31 45	Seward	197 31 22	2755.8	3013.7	1.71
			267 25 29	Prince s Bay	87 27 33	4475.8	4894.6	2.78
Perth Amboy, Episcopal church	40 30 10.64	74 15 36.15	229 30 10	Gage	49 31 02	2488.0	2720.8	1.54
			218 06 33	Dubois	38 07 24	3017.9	3300.3	1.87
South Amboy Depot	40 29 26.32	74 16 15.58	254 29 50	Ward's Point	74 30 48	2189.5	2394.4	1.36
			356 41 40	Seward	176 41 42	1032.3	1128.9	0.64
Keyport Spire	40 26 12.41	74 11 47.24	218 52 09	Conaskonck Point, (2)	38 53 03	3097.7	3387.5	1.92
			172 59 20	Prince's Bay	352 58 54	7836.2	8569.4	4.87
Rutherford Observatory, transit, 1858.	40 43 48.79	73 58 54.43	...	...	...	...	...	...
From Newburg to Poughkeepsie.								
Butter Hill Clough	41 25 49.20	73 58 43.26	323 07 41	Constitution Island	143 08 39	3373.9	3689.6	2.10
			286 29 46	Plum Bush	106 31 47	4403.8	4815.9	2.74
Breakneck Point	41 26 30.12	73 58 24.76	338 04 09	Constitution Island	158 04 54	4270.5	4670.1	2.65
			18 46 57	Butter Hill Clough	198 46 45	1333.3	1458.1	0.83
Polypus Island	41 27 16.46	73 59 03.36	158 27 05	Robinson	338 26 19	4397.8	4809.3	2.73
			188 46 23	Spy Hill	8 46 47	5407.5	5913.5	3.36

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Newburg to Poughkeepsie. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Van Amburg	41 27 34.81	73 58 36.12	147 28 55	Robinson	327 27 51	4180.0	4571.1	2.60
			182 18 53	Spy Hill	2 18 59	4782.1	5229.6	2.97
Sloop Hill	41 27 14.43	74 01 08.17	214 31 01	Spy Hill	34 32 48	6563.3	7177.4	4.08
			259 53 05	Van Amburg	79 54 46	3583.9	3919.2	2.23
Round Top	41 26 09.18	74 00 28.69	223 39 06	Polypus Island	43 40 02	2868.9	3137.3	1.78
			155 31 22	Sloop Hill	335 30 56	2211.4	2418.3	1.37
New Windsor	41 28 41.17	74 00 30.37	359 31 28	Round Top	179 31 29	4688.5	5197.2	2.91
			322 17 59	Polypus Island	142 18 57	3301.9	3610.8	2.05
Plum Point	41 28 49.29	73 58 33.63	28 32 01	Round Top	208 30 44	5621.1	6147.1	3.49
			13 48 22	Polypus Island	193 48 02	2948.4	3224.3	1.83
Lee	41 28 48.04	74 01 03.47	269 21 10	Plum Point	89 22 50	3489.9	3816.4	2.17
			303 26 35	Van Amburg	123 28 12	4097.3	4480.7	2.54
Hubbard	41 26 24.22	73 59 09.15	184 45 53	Polypus Island	4 45 57	1617.5	1768.8	1.00
			199 23 20	Van Amburg	19 23 42	2308.6	2521.6	1.43
Hedges	41 25 43.98	74 02 20.78	197 31 48	Lee	17 32 39	5951.6	6511.8	3.70
			253 20 11	Round Top	73 21 25	2716.1	2970.2	1.69
Dean	41 27 27.38	74 04 01.83	295 58 03	Round Top	116 00 24	5503.5	6018.5	3.42
			238 57 58	Lee	58 59 56	4828.8	5280.6	3.00
Delancey	41 26 36.61	74 03 03.36	283 13 59	Round Top	103 15 41	3688.7	4033.8	2.29
			214 26 49	Lee	34 28 08	4917.2	5377.3	3.05
Balmville	41 31 43.97	74 00 04.71	292 36 31	Bald Hill	112 40 03	8051.2	8804.5	5.00
			351 49 23	Crow's Nest	171 50 18	13564.3	14833.5	8.43
Railroad, (52)	41 33 00.72	73 57 59.67	145 47 38	Truesdall	325 47 11	1671.6	1828.0	1.04
			85 24 43	Weed	265 23 36	2361.5	2582.5	1.47
Fowler's House	41 34 24.55	73 54 09.49	105 50 47	Bingham	285 47 26	7280.5	7961.7	4.52
			5 42 36	Bald Hill	185 42 13	8092.8	8850.0	5.03
Low Point	41 33 20.05	73 57 43.24	73 59 08	Weed	253 57 50	2845.1	3111.3	1.77
			212 11 32	Old Troy	32 12 20	3151.7	3446.6	1.96
Brinkerhoff	41 33 44.15	73 57 13.56	207 16 14	Old Troy	27 16 42	2164.3	2366.8	1.34
			65 56 22	Weed	245 54 44	3748.1	4098.8	2.33
Limestone Point	41 34 24.17	73 57 29.11	343 43 28	Brinkerhoff	163 43 38	1286.0	1406.3	0.80
			242 59 13	Old Troy	62 59 52	1517.3	1659.3	0.94
Hampton	41 36 18.77	73 57 22.44	332 45 40	Angell	152 46 33	4058.7	4438.5	2.52
			265 08 32	Sheafe	85 09 41	2425.0	2651.9	1.51
Purdy, (2)	41 35 28.25	73 57 16.93	232 22 49	Sheafe	52 23 55	2889.4	3159.8	1.79
			175 19 00	Hampton	355 18 56	1563.7	1710.0	0.97
Deyo	41 42 21.53	73 57 54.28	280 40 34	Vervalin	100 45 26	10334.7	11301.7	6.42
			10 33 06	Golden Ridge	190 32 30	6871.4	7514.4	4.27
Woolley	41 45 38.29	73 58 00.46	4 58 10	Golden Ridge	184 57 38	12873.7	14078.3	8.00
			358 39 09	Deyo	178 39 13	6071.1	6639.2	3.77
Milton	41 38 54.75	73 57 03.29	243 33 52	Vervalin	63 38 10	10025.2	10963.2	6.23
			14 57 18	Mansion Hill	194 57 02	2221.5	2429.4	1.38
Jobes	41 41 55.84	73 57 11.55	20 39 07	Golden Ridge	200 38 04	6371.9	6968.1	3.96
			358 02 15	Milton	178 02 21	5589.9	6112.9	3.47
Dubois	41 41 20.02	73 56 43 82	30 44 32	Golden Ridge	210 43 09	5651.2	6180.0	3.51
			149 52 50	Jobes	329 52 32	1277.5	1397.0	0.79
Davis	41 43 31.98	73 55 06.50	28 55 57	Dubois	208 54 52	4650.8	5086.0	2.89
			60 44 50	Deyo	240 42 58	4445.7	4861.7	2.76
Leroy	41 45 28.93	73 56 58.59	12 33 12	Deyo	192 32 35	5922.4	6476.6	3.68
			310 57 25	Vervalin	131 01 40	11742.5	12841.2	7.30
Boorman	41 45 18.06	73 55 34.80	348 41 57	Davis	168 42 16	3337.1	3649.3	2.07
			99 49 49	Leroy	279 48 53	1964.5	2148.3	1.22
Hoyt	41 43 06.29	73 56 39.01	249 39 10	Davis	69 40 12	2295.9	2510.7	1.43
			1 56 36	Dubois	181 56 33	3279.9	3586.8	2.04
Haley	41 44 31.19	73 56 47.10	308 08 44	Davis	128 09 51	2956.3	3232.9	1.84
			229 06 43	Boorman	49 07 31	2209.4	2416.1	1.37
Coe	41 44 02.67	73 57 27.79	286 09 15	Davis	106 10 49	3399.3	3717.4	2.11
			354 31 12	Jobes	174 31 23	3930.6	4298.4	2.44
Summer House Hill	41 39 47.10	73 56 54.33	174 16 15	Jobes	354 16 04	3991.2	4364.6	2.48
			252 00 34	Vervalin	72 04 46	9220.5	10083.3	5.73
Mine Point	41 40 46.45	73 56 03.80	143 48 16	Jobes	323 47 31	2652.8	2901.0	1.65
			32 33 34	Summer House Hill	212 33 00	2172.0	2375.2	1.35

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Newburg to Poughkeepsie. Sketch B, No 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Dog Head Cove Point	41 44 01.67	73 56 26.66	296 18 22	Davis	116 19 15	2066.1	2259.4	1.28
			4 32 58	Dubois	184 32 47	5002.2	5470.3	3.11
Poughkeepsie Second Point	41 43 06.50	73 56 01.30	161 00 13	Dog Head Cove Point	340 59 56	1799.9	1968.3	1.12
			89 35 18	Hoyt	269 34 53	871.6	953.2	0.54
Roosevelt	41 44 20.32	73 55 55.79	51 05 53	Dog Head Cove Point	231 05 33	916.5	1002.3	0.57
			3 12 05	Poughkeepsie Second Point.	183 12 01	2280.8	2494.2	1.42
Crumb Elbow Point	41 45 05.70	73 56 22.00	336 36 17	Roosevelt	156 36 35	1525.3	1668.0	0.95
			3 06 51	Dog Head Cove Point	183 06 48	1978.4	2163.5	1.23
Railroad, (68)	41 45 13 47	73 55 54.71	0 52 24	Roosevelt	180 52 23	1639.9	1793.3	1.02
			18 25 48	Dog Head Cove Point	198 25 27	2335.1	2553.6	1.45
Spring Brook	41 39 25.25	73 56 10.09	123 22 22	Summer-house Hill	303 21 53	1225.2	1339.8	0.76
			30 18 18	Mansion Hill	210 17 26	3575.0	3910.2	2.22
Old Lime-kiln	41 37 13.00	73 56 37.11	130 05 41	Mansion Hill	310 05 07	1541.3	1685.5	0.96
			169 04 46	Milton	349 04 29	3196.7	3495.8	1.99
Bishop	41 38 42.05	73 56 20.78	158 51 21	Summer-house Hill	338 50 59	2151.4	2352.7	1.33
			111 42 54	Milton	291 42 26	1058.6	1157.7	0.66
Barnegat	41 37 31.31	73 56 35.01	4 55 25	Old Lime-kiln	184 55 24	567.2	620.3	0.35
			188 34 54	Bishop	8 35 03	2207.0	2413.5	1.37
Poughkeepsie, Catholic Church	41 42 30.64	73 55 55.00	210 38 04	Davis	30 38 36	2199.3	2405.1	1.37
			179 41 32	Roosevelt	359 41 31	3383.5	3700.1	2.10
Poughkeepsie, Old Dutch Reformed Church.	41 42 13.51	73 55 29.93	283 46 18	Vervalin	103 49 34	7019.5	7676.3	4.36
			18 16 42	Mansion Hill	198 15 23	8717.1	9532.8	5.42
Rock Point	41 40 10.85	73 56 16.70	195 12 10	Mine Point	15 12 19	1137.8	1244.3	0.71
			24 39 40	Milton	204 39 09	2583.2	2824.9	1.60
Peck	41 35 19.33	73 57 19.44	177 27 50	Mansion Hill	357 27 44	4503.6	4925.0	2.80
			264 15 12	Underhill	84 19 00	7970.2	8716.0	4.95
Blue Point Hill	41 40 44.46	73 56 41.02	9 52 04	Summer-house Hill	189 51 55	1796.0	1964.0	1.11
			11 08 06	Mansion Hill	191 07 35	5636.9	6164.3	3.50
New Hamburg	41 35 20.80	73 56 42.29	86 58 48	Peck	266 58 23	861.4	942.0	0.53
			166 37 30	Mansion Hill	346 37 00	4578.0	5006.4	2.84
Howland	41 36 16 59	73 56 20.37	16 26 24	New Hamburg	196 26 09	1794.3	1962.2	1.11
			92 41 18	Hampton	272 40 37	1438.8	1573.4	0.89
Hunt	41 37 59.35	73 56 28.07	10 31 07	Barnegat	190 31 02	879.8	962.1	0.55
			187 18 15	Bishop	7 18 20	1328.0	1452.3	0.82
Ackerly	41 37 10.28	73 57 04.41	262 26 15	Old Lime-kiln	82 26 33	637.6	697.3	0.40
			226 21 33	Barnegat	46 21 53	940.4	1028.4	0.58
Morse	41 40 10.87	73 56 16.68	195 12 09	Mine Point	15 12 18	1137.8	1244.3	0.71
			49 54 59	Summer-house Hill	229 54 34	1137.8	1244.3	0.71
Egan's Wharf	41 40 25.51	73 56 44.51	235 32 10	Mine Point	55 32 37	1142.4	1249.3	0.71
			305 03 28	Morse	125 03 46	786.3	859.9	0.49
Poughkeepsie, New Dutch Reformed Church.	41 42 13.41	73 55 29.70	23 26 51	Summer-house Hill	203 25 55	4918.8	5379.0	3.06
			19 27 39	Milton	199 26 37	6499.1	7107.2	4.04
Fowler	41 38 15.44	73 56 58.35	226 38 06	Bishop	46 38 31	1195.9	1307.8	0.74
			345 40 59	Old Lime kiln	165 41 13	1987.8	2173 8	1.23
Dog Head Point, (2)	41 44 01.65	73 56 26.66	231 04 37	Roosevelt	51 04 58	916.8	1002.6	0.57
			296 17 37	Davis	116 18 30	2066.0	2259.3	1.28
Crosby	41 43 30.60	73 55 57.41	145 18 55	Dog Head Point, (2)	325 18 36	1187.6	1298.7	0.74
			181 23 10	Roosevelt	1 23 11	1552.9	1698.2	0.96
Haley's Quarry	41 44 20.40	73 56 27.94	308 26 28	Davis	128 27 22	2402.6	2627.4	1.49
			270 10 41	Roosevelt	90 11 02	742.7	812.2	0.46
Reynolds	41 42 36.50	73 56 02.84	169 44 53	Haley's Quarry	349 44 39	3257.3	3562.1	2.02
			217 15 45	Davis	37 16 22	2150.3	2351.5	1.33
New Paltz North	41 43 07 39	73 56 34.42	201 38 17	Roosevelt	21 38 43	2420 4	2646.9	1.50
			322 31 57	Reynolds	142 32 18	1200.1	1312.4	0.74
Elting Pier	41 42 40.45	73 56 38.70	227 06 14	Poughkeepsie Second Point.	47 06 39	1180.1	1290.5	0.73
			278 21 39	Reynolds	98 22 03	837.8	916.2	0.52
Iron Works	41 42 05.99	73 56 06.90	145 20 19	Elting Pier	325 19 58	1292.6	1413.5	0.80
			185 41 07	Reynolds	5 41 10	946.0	1034.5	0.59
Louisburg	41 42 15.28	73 56 41.77	185 13 17	Elting Pier	5 13 19	779.8	852.8	0.48
			289 34 10	Iron Works	109 34 33	855.6	935.7	0.53
Yellow Point	41 41 13.35	73 56 32.59	173 39 38	Louisburg	353 39 32	1922.3	2102.2	1.19
			200 05 26	Iron Works	20 05 43	1729.1	1890.9	1.07

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Poughkeepsie to Rhinebeck. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Fox's Point	41 41 26.40	73 56 01.94	60 24 03	Yellow Point	240 23 43	815.1	891.4	0.51
			174 38 12	Iron Works	354 38 09	1226.6	1341.4	0.76
Quarry Wharf	41 41 33.87	73 56 42.69	181 09 27	Louisburg	1 09 28	1277.7	1397.2	0.79
			283 40 05	Fox's Point	103 40 32	974.5	1065.7	0.60
Blue Point	41 40 50.40	73 56 30.07	210 20 56	Fox's Point	30 21 15	1287.3	1407.7	0.80
			281 23 21	Mine Point	101 23 38	619.6	677.6	0.38
From Poughkeepsie to Rhinebeck.								
Dennis, (1)	41 47 25.44	73 50 42.21	46 50 03	Deyo	226 45 15	13693.9	14975.2	8.51
			359 09 47	Vervalin	179 09 52	11298.0	12355.1	7.02
Stewart	41 46 11.39	73 57 50.33	311 49 14	Vervalin	131 54 04	13505.2	14768.9	8.39
			5 34 04	Golden Ridge	185 33 25	13911.7	15213.4	8.64
Lloyd	41 49 15.01	73 52 54.53	50 21 04	Stewart	230 17 47	8872.2	9702.4	5.51
			347 36 24	Vervalin	167 37 57	15026.3	16432.3	9.34
Dennis, (2)	41 47 25.40	73 50 42.44	77 01 38	Stewart	256 56 53	10140.4	11089.2	6.30
			137 58 20	Lloyd	317 56 52	4552.8	4978.8	2.83
Prospect Hill	41 52 25.74	73 57 30.33	312 44 26	Lloyd	132 47 30	8665.5	9476.3	5.38
			2 17 28	Stewart	182 17 15	11557.6	12639.0	7.18
Traver	41 55 02.86	73 52 21.81	55 44 58	Prospect Hill	235 41 32	8605.8	9411.0	5.35
			4 01 30	Lloyd	184 01 06	10757.4	11764 0	6.68
Terry	41 56 20.10	73 57 59.97	286 58 39	Traver	107 02 25	8146.6	8908.9	5.06
			354 36 03	Prospect Hill	174 36 23	7262.3	7941.8	4.51
Burhans	42 00 27.13	73 56 54.40	11 12 36	Terry	191 11 52	7768.8	8495.7	4.83
			327 52 14	Traver	147 55 16	11809.6	12914.6	7.34
Staats	42 02 17.72	73 52 58.49	32 11 41	Terry	212 08 20	13033.2	14252.7	8.10
			356 23 44	Traver	176 24 06	13442.2	14700.0	8.35
Welch	41 57 21.96	73 52 05 64	76 52 17	Terry	256 48 20	8380.3	9164.4	5.21
			4 57 39	Traver	184 57 28	4307.3	4710.3	2.68
Boitz	41 55 52.51	73 49 11 97	70 42 57	Traver	250 40 50	4634.1	5067.7	2.88
			94 03 10	Terry	273 57 17	12192.0	13332.8	7.57
Teator	42 00 09.55	73 46 45.55	65 33 15	Terry	245 25 44	17063.9	18660.6	10.60
			39 19 32	Traver	219 15 47	12225.9	13369.9	7.60
Barnes	41 48 12.07	73 50 41.05	1 16 37	Dennis, (2)	181 16 36	1439.8	1574.5	0 90
			69 27 07	Stewart	249 22 21	10587.3	11578.0	6.58
Adams	41 48 08.07	73 57 18.40	278 09 26	Dennis, (2)	98 13 50	9234.7	10098.8	5.74
			11 34 44	Stewart	191 34 23	3674.2	4018.0	2.26
Crumb Elbow Ridge	41 45 40.64	73 57 03.35	175 37 55	Adams	355 37 45	4561.2	4988.0	2.83
			131 09 40	Stewart	311 09 06	1441.1	1575.9	0.90
Van Wagner Hill	41 44 12.13	73 53 59.34	318 27 52	Vervalin	138 30 08	7123.0	7789.5	4.42
			124 36 23	Stewart	304 33 49	6480.7	7087.1	4.03
Hyde Park North	41 47 17.96	73 56 30.49	14 11 11	Crumb Elbow Ridge	194 10 49	3096.7	3386.4	1.92
			144 25 08	Adams	324 24 36	1900.5	2078.3	1.18
Bard's Rock	41 48 13.88	73 56 23.49	81 57 17	Adams	261 56 40	1280 0	1399.8	0.79
			5 21 14	Hyde Park, north	185 21 09	1732 3	1894.4	1.08
Astor	41 48 26.50	73 56 55.02	298 08 47	Bard's Rock	118 09 08	825.3	902.5	0.51
			345 00 20	Hyde Park, north	165 00 36	2188.6	2393.4	1.36
Green Point	41 46 07.98	73 56 32.32	163 58 59	Adams	343 58 28	3854.3	4214.9	2.40
			40 21 13	Crumb Elbow Ridge	220 20 52	1106.7	1210.2	0.69
Taylor	41 47 51.26	73 57 00.24	0 59 59	Crumb Elbow Ridge	180 59 57	4122.6	4508.4	2.56
			234 30 19	Bard's Rock	54 30 43	1041.9	1139.4	0.65
Russell Pier	41 47 05.69	73 57 06.43	185 26 57	Taylor	5 27 01	1505.4	1646.3	0.93
			245 27 34	Hyde Park, north	65 27 58	912.1	997.4	0.57
Hyde Park South	41 46 31.96	73 56 34.00	183 15 55	Hyde Park, north	3 15 57	1421.6	1554.6	0.88
			144 15 39	Russell Pier	324 15 18	1282.0	1402.0	0.80
Railroad, (68)	41 45 13.49	73 55 54.70	117 51 05	Crumb Elbow Ridge	297 50 19	1793.4	1961.2	1.11
			152 39 58	Green Point	332 39 33	1892.5	2069.6	1.18
Crumb Elbow East	41 45 46.42	73 56 15.19	335 00 46	Railroad, (68)	155 01 00	1121.0	1225.9	0.70
			7 08 45	Crumb Elbow Point	187 08 40	1266.0	1384.4	0.78
West Park	41 47 28.57	73 57 06.62	291 25 03	Hyde Park, north	111 25 27	895.9	979.7	0.56
			215 27 39	Bard's Rock	35 28 08	1715.9	1876.5	1.07
White House	41 46 31.15	73 57 02.22	206 53 34	Hyde Park, north	26 53 56	1619.3	1770.8	1.01
			267 48 30	Hyde Park, south	87 48 49	652.1	713.1	0.41

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Poughkeepsie to Rhinebeck. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Boorman's Point	46 46 16.98	73 56 34.44	181 15 27	Hyde Park, south	1 15 27	462.0	505.2	0.29
			124 15 52	White House	304 15 34	776.2	848.8	0.48
Brown's Wharf	41 46 17.07	73 57 00.91	270 16 27	Boorman's Point	90 16 45	611.9	669.1	0.38
			293 00 47	Green Point	113 01 06	716.8	783.9	0.45
Boat Landing	41 45 35.78	73 56 32.98	231 24 20	Crumb Elbow East	51 24 32	526.3	575.6	0.33
			153 06 52	Brown's Wharf	333 06 33	1428.1	1561.7	0.89
Bolle's Island	41 48 48.28	73 56 24.82	46 02 48	Astor	226 02 28	968.2	1058.9	0.60
			2 41 28	Hyde Park, north	182 41 24	2789.3	3050.3	1.73
Southard	41 48 55.94	73 56 54.56	288 59 07	Bolle's Island	108 59 27	725.9	793.8	0.45
			331 04 13	Bard's Rock	151 04 34	1482.5	1621.2	0.92
Blunt's Island	41 49 06.33	73 56 19.87	11 35 19	Bolle's Island	191 35 16	568.2	621.4	0.35
			68 11 23	Southard	248 11 00	862.2	942.9	0.54
Pelham Signal	41 49 21.87	73 57 01.72	296 24 45	Blunt's Island	116 25 13	1078.3	1179.2	0.67
			320 35 11	Bolle's Island	140 35 35	1341.1	1466.6	0 83
Wilkes	41 49 52.51	73 56 13.85	49 26 54	Pelham Signal	229 26 22	1453.8	1589.8	0.90
			5 34 21	Blunt's Island	185 34 17	1431.7	1565.7	0.89
Indian Rock	41 49 55.95	73 57 02.30	359 15 45	Pelham Signal	179 15 45	1051.4	1149.8	0.65
			275 24 50	Wilkes	95 25 22	1123.0	1228.1	0.70
Pelham Dock	41 50 33.79	73 56 58.22	4 36 52	Indian Rock	184 36 49	1171.3	1280.9	0.73
			321 12 11	Wilkes	141 12 40	1633.9	1786.8	1.01
Cliffwood	41 51 29.23	73 56 43.21	222 24 46	Traver	42 27 40	8929.8	9765.3	5.55
			308 06 26	Lloyd	128 08 58	6706.2	7333.7	4.17
Pell	41 50 32.31	73 57 25.42	178 08 50	Prospect Hill	358 08 47	3500 8	3828.4	2 17
			209 00 13	Cliffwood	29 00 41	2007.6	2195.4	1.25
Pollock	41 49 40.17	73 57 16.95	193 01 21	Cliffwood	13 01 43	3453.4	3776.5	2.15
			255 20 30	Wilkes	75 21 12	1504.9	1645.7	0.93
Mulford Pier	41 50 40.63	73 56 20.71	76 17 15	Pelham Dock	256 16 50	891.0	974.4	0.55
			160 55 16	Cliffwood	340 55 01	1586.9	1735.4	0.99
Rock	41 50 09.24	73 56 19 44	130 16 04	Pelham Dock	310 15 38	1172.2	1281.9	0.73
			33 43 40	Pelham Signal	213 43 12	1756.8	1921.2	1.09
Cave Point	41 51 27.94	73 56 38.19	344 32 43	Mulford Pier	164 32 55	1514 1	1655.8	0.94
			15 27 39	Pelham Dock	195 27 26	1733.3	1895.5	1.08
Meadow Point	41 51 56.53	73 56.35.66	225 29 10	Traver	45 32 00	8202.4	8969.9	5.10
			314 18 30	Lloyd	134 20 58	7130.8	7798.0	4.43
Lewis' Pier	41 51 17.63	73 56 05.52	112 25 02	Cliffwood	292 24 37	940.0	1027.9	0.58
			112 51 26	Cave Point	292 51 04	818.0	894.5	0.51
Elting Signal	41 53 47.59	73 58 03.64	181 01 46	Terry	1 01 48	4705.8	5146.1	2.92
			253 32 40	Traver	73 36 29	8212.5	8980.9	5.10
Van Akin	41 52 50.97	73 57 12.83	332 57 39	Meadow Point	152 58 04	1885.5	2061.9	1.17
			238 43 54	Traver	58 47 09	7845.0	8579.1	4.87
Railroad, (80)	41 52 22.23	73 55 24.23	109 30 30	Van Akin	289 29 17	2656.1	2904.6	1.65
			39 30 35	Pell	219 29 14	4394.0	4805.1	2.73
Hemlock Point	41 52 53.63	73 57 02.66	293 06 48	Railroad, (80)	113 07 54	2467.6	2698.5	1.53
			340 32 15	Meadow Point	160 32 33	1868.5	2043.3	1.16
Jones' Island	41 52 56.73	73 55 54.27	86 32 38	Hemlock Point	266 31 52	1579.4	1727.2	0.98
			84 23 57	Van Akin	264 23 05	1819.9	1990.2	1.13
Ellerslie	41 53 30.81	73 56 26.56	40 57 06	Van Akin	220 56 35	1627.4	1779.7	1.01
			325 48 42	Railroad, (80)	145 49 24	2557.5	2796.8	1.59
Port Ewen Signal	41 54 21.67	73 58 09.20	183 19 52	Terry	3 19 58	3659.7	4002.1	2.27
			353 02 59	Elting Signal	173 03 03	1059.2	1158.3	0.66
Railroad, (85)	41 54 14.40	73 57 01.81	98 13 36	Port Ewen Signal	278 12 51	1569.3	1716.1	0.97
			59 52 36	Elting Signal	239 51 55	1647.7	1801.9	1.02
Kipp	41 55 56.74	73 56 14.09	106 28 14	Terry	286 27 03	2543.2	2781.2	1.58
			42 08 03	Port Ewen Signal	222 06 46	3954.2	4324.2	2.46
Rhinebeck	41 55 10.47	73 56 52.28	144 01 49	Terry	324 01 04	2654.5	2903.9	1.65
			49 40 06	Port Ewen Signal	229 39 15	2325 5	2543.1	1.44
Kingston Point	41 55 38.84	73 57 28.24	316 33 48	Rhinebeck	136 34 12	1205.1	1317.9	0.75
			346 50 22	Railroad, (85)	166 50 40	2675.3	2925.6	1.66
Big Rock Point	41 53 31.86	73 57 30.58	271 14 37	Ellerslie	91 15 20	1476.1	1614.2	0.92
			206 48 32	Railroad, (85)	26 48 51	1470.3	1607.9	0.91
Railroad, (86)	41 54 41.59	73 56 59.88	68 57 58	Port Ewen Signal	248 57 12	1711.6	1871.8	1.06
			159 41 45	Kingston Point	339 41 26	1883.0	2059.2	1.17

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Poughkeepsie to Rhinebeck. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Gurnee	41 56 45 27	73 57 39.19	307 21 51	Kipp	127 22 48	2466.5	2697.3	1.53
			8 52 25	Port Ewen Signal	188 52 05	4483.5	4903.0	2.79
Slate Wharf	41 55 32.34	73 56 39.94	128 38 33	Terry	308 37 40	2360.0	2580.8	1.46
			100 13 03	Kingston Point	280 12 27	1130 5	1236.3	0.70
Rondout Light-house	41 55 11.93	73 57 41.63	314 12 00	Railroad, (86)	134 12 28	1342.0	1467 6	0.83
			272 15 37	Rhinebeck	92 16 10	1137.9	1244.4	0.71
Evertson	41 54 44.57	73 58 06.33	273 25 31	Railroad, (86)	93 26 15	1533.9	1677.4	0.95
			244 54 09	Rhinebeck	64 54 59	1884.0	2060.3	1.17
Sleight's Hill	41 54 51.30	73 58 20.69	189 52 49	Terry	9 53 03	2780.8	3041.0	1.73
			235 17 51	Kipp	55 19 15	3547.3	3879.2	2.20
Hanaburgh	41 52 37.57	73 54 13.53	58 35 48	Cliffwood	238 34 08	4044 5	4422.9	2.51
			68 53 32	Meadow Point.	248 51 57	3513.2	3841 9	2.18
Abiel Smith	41 54 57.64	73 59 25.61	247 31 51	Kipp	67 33 59	4774.3	5221.0	2.97
			318 50 10	Elting Signal	138 51 04	2870.3	3138.9	1.78
Tunnel Point	41 57 02.53	73 56 26.13	28 59 32	Kingston Point	208 58 51	2951.8	3228.0	1.83
			20 29 30	Elting Signal	200 28 25	6419.7	7020.4	3.99
Flatbush	41 57 16.83	73 57 25.64	326 17 12	Kipp	146 18 00	2969.7	3247.6	1.85
			287 50 07	Tunnel Point	107 50 47	1439.8	1574.5	0.89
Chamberlain	41 58 10.90	73 56 06.23	47 38 04	Flatbush	227 37 11	2475.2	2706.8	1.54
			12 15 37	Tunnel Point	192 15 24	2158.5	2360.5	1.34
Livingston	41 58 28.17	73 56 57.16	344 51 58	Tnnnel Point	164 52 19	2737.0	2993.1	1.70
			16 35 46	Flatbush	196 35 27	2296.6	2511.5	1.43
Ten Broeck	41 58 13.38	73 57 03.06	16 35 57	Flatbush	196 35 42	1820.3	1990.6	1.13
			338 44 18	Tunnel Point	158 44 42	2345.3	2564.7	1.46
Vandemark	41 57 55.06	73 57 09.26	194 10 23	Ten Broeck	14 10 27	582.7	637.2	0.36
			17 44 24	Flatbush	197 44 13	1238.4	1354.3	0.77
Mills' Wharf	41 58 10.24	73 56 09.33	116 40 28	Livingston	296 39 56	1232.3	1347.6	0.76
			94 28 42	Ten Broeck	274 28 06	1240.8	1356.9	0.77
Knickerbocker Pier	41 57 56.72	73 57 04.61	21 28 57	Flatbush	201 28 43	1322.7	1446.5	0.82
			251 51 19	Mills' Wharf	71 51 56	1339.4	1464.7	0.83
Garrison	41 56 53.57	73 56 19.70	65 55 14	Terry	245 54 07	2529.5	2766.2	1.57
			355 46 41	Kipp	175 46 45	1757.7	1922.2	1.09
Port Ewen Bell House	41 54 22.20	73 57 54.36	281 14 23	Railroad, (85)	101 14 58	1234.9	1350.4	0.77
			340 33 51	Big Rock Point	160 34 07	1646.9	1801.0	1.02
Rondout, Roman Catholic church	41 55 17.69	73 58 56.85	46 58 36	Abiel Smith	226 58 17	906.4	991.2	0.56
			292 26 13	Railroad, (86)	112 27 31	2916.1	3189.0	7 81
Cement	41 55 15.00	73 58 34.79	65 25 26	Abiel Smith	245 24 52	1287.3	1407.7	0.80
			273 22 58	Rhinebeck	93 24 06	2365.8	2587.2	1.47
Dinsmore	41 51 38.19	73 55 41.92	114 32 08	Meadow Point	294 31 32	1362 1	1489.5	0.84
			196 42 51	Railroad, (80)	16 43 03	1418.4	1551.1	0.88
Esopus Light house	41 52 05.30	73 56 12.39	142 08 50	Hemlock Point	322 08 16	1888.5	2065.2	1.17
			63 15 06	Meadow Point	243 14 51	600.9	657.1	0.37
Sukely's Observatory	41 57 21.04	73 55 18.77	63 09 20	Terry	243 07 32	4160.8	4550.1	2.58
			123 55 18	Ten Broeck	303 54 03	2893.9	3164.7	1.80
Whiskey Point.	41 57 10 35	73 57 21.55	342 24 46	Slate Wharf	162 25 14	3172.3	3469.1	1.97
			325 36 36	Kipp	145 37 21	2751.4	3008.8	1.71
Esopus, Dutch Reformed church.	41 51 11.30	73 57 53.37	179 05 12	Terry	359 05 08	9527.9	10419.4	5 92
			193 01 30	Prospect Hill	13 01 45	2356.9	2577.4	1.40
Curtis' Tower	41 48 03.29	73 56 06.48	151 27 19	Pollock	331 26 32	3402.9	3721.3	2.11
			243 26 14	Lloyd	63 28 22	4952.1	5415.5	3.08
Jones' House Tower	41 53 10.51	73 55 51.58	24 00 25	Meadow Point	203 59 56	2498.5	2732.3	1.55
			58 45 52	Prospect Hill	238 44 46	2663.0	2912.2	1 65
West Park Episcopal Church	41 48 14 75	73 57 13.46	330 28 27	Hyde Park, north	150 28 56	2012.9	2201.2	1.25
			357 11 07	Crumb Elbow Ridge	177 11 14	4759.9	5205.3	2.96
Weist	41 49 41.46	73 58 12.54	190 52 17	Prospect Hill	10 52 45	5160.4	5643.3	3.21
			336 32 51	Adams	156 33 27	3140.4	3434.2	1.95
Bruen	41 50 00.07	73 57 39 74	182 45 54	Prospect Hill	2 46 00	4498.9	4919.9	2.80
			351 53 07	Adams	171 53 21	3490.0	3816.6	2.17
Red Hook Spire	41 58 17.86	73 52 23.45	33 05 14	Prospect Hill	213 01 49	12961.1	14173.9	8.05
			359 38 25	Traver	179 38 26	6015.9	6578.8	3.74
Wittenberg, Presbyterian church.	41 53 51 16	73 51 44.39	158 42 09	Traver	338 41 44	2374.0	2596.1	1.47
			118 00 07	Terry	297 55 56	9798.0	10714.8	6.09

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Poughkeepsie to Rhinebeck. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ′		° ′ ″	*Metres.*	*Yards.*	*Miles.*
G. A. Smith	41 54 18.07	74 00 30.71	285 29 28	Elting	105 31 06	3517.6	3846.7	2.19
			236 39 38	Cement	56 40 55	3196.7	3495.8	1.99
Ellsworth	41 53 30.34	74 00 02.69	156 19 10	G. A. Smith	336 18 51	1607.6	1758.0	1.00
			212 05 39	Cement	32 06 38	3811.4	4168.0	2.37
Wilbur East	41 54 45.47	73 59 29.57	243 57 46	Kipp	63 59 57	5011.8	5480.7	3.11
			234 10 12	Cement	54 10 49	1556.5	1702 1	0.97
Copeland	41 54 38.76	73 59 21.90	139 30 33	Wilbur East	319 30 28	272.2	297.7	0.17
			224 08 38	Cement	44 09 09	1558.2	1704.0	0.97
Wilbur West	41 54 34.73	73 59 51.88	237 12 18	Wilbur East	57 12 33	611.7	668.9	0.38
			259 48 06	Copeland	79 48 26	702.0	767.7	0.44
Von Beck	41 54 27.62	73 59 06.08	206 14 43	Cement	26 15 04	1629.9	1782.4	1.01
			135 30 30	Wilbur East	315 30 14	772.2	844 5	0.48
Flannery	41 54 44.24	73 59 21.67	1 48 19	Copeland	181 48 19	168.9	184.7	0.10
			67 10 20	Wilbur West	247 10 00	755.5	826.2	0.47
Brooklyn Wharf	41 54 17.89	73 59 55.90	6 05 53	Ellsworth	186 05 48	1475.1	1613.1	0.92
			90 23 44	G. A. Smith	270 23 21	802.4	877.5	0.50
Lawrence Wharf	41 53 57.02	74 00 44.27	239 59 35	Brooklyn Wharf	60 00 07	1287.4	1407.9	0.80
			310 39 09	Ellsworth	130 39 37	1263.2	1381.4	0.78
Crow's Point	41 54 03.85	74 00 10.47	133 14 18	G. A. Smith	313 14 04	640.2	700.1	0.40
			217 47 52	Brooklyn Wharf	37 48 02	548.1	599.4	0.34
Booth	41 54 20.52	74 00 05.58	289 58 57	Brooklyn Wharf	109 59 03	237.4	259.6	0.15
			357 32 44	Ellsworth	177 32 46	1549.5	1694.5	0.96
Donovan's Kiln	41 54 12.70	74 00 17.44	252 08 21	Brooklyn Wharf	72 08 35	521.7	570.5	0.32
			345 25 02	Ellsworth	165 25 12	1350.2	1476.5	0.84
Hamilton Island	41 53 58.62	74 00 21.44	333 39 08	Ellsworth	153 39 21	973.4	1064.5	0.60
			224 43 01	Brooklyn Wharf	44 43 18	836.6	914.9	0.52
New Salem	41 53 47.51	74 00 42.14	228 40 16	Brooklyn Wharf	48 40 47	1419.4	1552.2	0.88
			300 12 39	Ellsworth	120 13 05	1052.3	1150.8	0.65
Tremper	41 54 38.93	73 59 01.41	208 50 53	Cement	28 51 11	1270.5	1389.4	0.79
			107 16 32	Wilbur East	287 16 13	679.6	743.2	0.42
Rolfe's Quarryy	41 54 20.10	73 59 25.13	214 23 51	Cement	34 24 25	2052.6	2244.7	1.27
			87 37 41	G. A. Smith	267 36 57	1512.6	1654.1	0.94
Sleight's Ferry	41 55 03.08	73 58 30.74	82 26 31	Abiel Smith	262 25 54	1275.4	1394.7	0.79
			165 43 55	Cement	345 43 52	379.3	414.8	0.23
South Rondout	41 54 39.75	73 59 13.74	334 46 09	Von Beck	154 46 14	414.0	452.7	0.26
			219 31 16	Cement	39 31 42	1409.8	1541.7	0.88
Sleightsburg, (1)	41 54 54.90	73 58 39.36	94 32 24	Abiel Smith	274 31 53	1068.9	1168.9	0.66
			189 37 56	Cement	9 37 59	628.9	687.7	0.39
Sleightsburg, (2)	41 54 50.36	73 58 44.99	103 29 57	Abiel Smith	283 29 30	962.5	1052.6	0.60
			197 10 05	Cement	17 10 12	795.6	870.0	0.49
Kingston Point, (2)	41 55 28.80	73 57 35.09	330 52 22	Railroad, (86)	150 52 46	1667.1	1823.1	1.04
			299 49 17	Rhinebeck	119 49 46	1136.9	1243.3	0.71
North	41 55 21.88	73 58 01.29	282 28 29	Rhinebeck	102 29 15	1628.6	1781.0	1.01
			250 31 19	Kingston Point, (2)	70 31 36	640.4	700.3	0.40
Rondout Light-house Signal	41 55 12.20	73 57 41.70	123 30 15	North	303 30 02	541.4	592.1	0.34
			272 40 26	Rhinebeck	92 40 59	1139.9	1246.6	0.71
Cornell Pier	41 55 09.32	73 58 26.23	265 03 24	Rondout L. H. Signal	85 03 54	1029.8	1126.1	0.64
			236 00 00	North	56 00 17	693.0	757.8	0.43
Port Ewen Dutch Reformed Church.	41 54 21.92	73 58 22.09	115 03 20	Wilbur, east	295 02 35	1716.4	1877.0	1.07
			169 51 54	Cement	349 51 46	1663.7	1819.4	1.03
Port Ewen Pier	41 54 35.75	73 57 47.98	260 46 00	Railroad, (86)	80 46 32	1123.1	1228.2	0.70
			230 09 15	Rhinebeck	50 09 52	1671.7	1828.1	1.04
Number 1	41 55 12.42	73 58 04.36	270 44 52	Rondout L. H. Signal	90 45 07	522.2	571.1	0.32
			193 36 44	North	13 36 46	300.4	328.5	0.18
Number 2	41 55 06.43	73 58 22.02	259 09 59	Rondout L. H. Signal	79 10 26	945.8	1034.3	0.59
			225 03 23	North	45 03 37	674.6	737.7	0.42
From Rhinebeck to Hudson.								
Upper Red Hook	42 01 22.38	73 50 20.84	79 22 29	Burhan's	259 18 06	9213.0	10075.1	5.72
			13 23 30	Trader	193 22 09	12034.9	13161.0	7.48
Mount Paulding	42 03 32.00	73 59 20.58	329 28 01	Burhan's	149 29 39	6620.6	7240.1	4.11
			287 48 26	Upper Red Hook	107 54 27	13040.4	14260.6	8.10

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Rhinebeck to Hudson. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Big Hill	42 05 16.74	73 52 37.67	33 28 35	Burhan's	213 25 43	10708.9	11710.9	6.65
			70 48 08	Mount Paulding	250 43 38	9808.5	10726.3	6.09
Round Top	42 05 12.28	73 52 04.11	341 28 56	Upper Red Hook	161 30 05	7479.7	8179.6	4.65
			72 54 04	Mount Paulding	252 49 12	10498.5	11480.8	6.52
Kortze	42 07 45.74	73 55 32.52	33 49 13	Mount Paulding	213 46 40	9420.1	10301.5	5.85
			318 50 15	Big Hill	138 52 12	6104.4	6675.6	3.79
Lasher	42 05 13.53	73 53 15.99	330 31 52	Upper Red Hook	150 33 49	8189.8	8956.1	5 09
			263 35 04	Big Hill	83 35 30	886.3	969.2	0.55
Catskill	42 11 21.78	74 01 55.16	346 13 16	Mount Paulding	166 15 00	14921.4	16317.6	9.27
			341 05 01	Burhan's	161 08 22	21346.2	23343.5	13.26
Blue Hill	42 11 03.62	73 48 35 91	91 49 35	Catskill	271 40 38	18346.3	20063.0	11.40
			27 26 23	Big Hill	207 23 41	12055.6	13183.6	7.49
Hover	42 08 27.34	73 51 42.70	221 37 40	Blue Hill	41 39 45	6451.5	7055.2	4.01
			76 21 17	Kortze	256 18 43	5430.8	5939.0	3.37
Turkey Point, north	42 01 02.13	73 56 02.41	351 37 08	Sukeley's Observatory	171 37 37	6894.1	7539.2	4 28
			241 07 08	Staats	61 09 11	4830.4	5282.4	3.00
Glasco Signal	42 02 37.97	73 56 19.46	352 26	Turkey Point, north	172 26 39	2982.5	3261.6	1.85
			277 40	Staats	97 43 05	4663.7	5100.1	2.90
Cruger's Wharf	42 02 51.30	73 56 02.44	359 59 21	Turkey Point, north	179 59 21	3368.0	3683.1	2.09
			283 44 51	Staats	103 46 54	4355.0	4762.5	2.71
Whitaker	42 01 27.38	73 56 12.10	175 33 16	Glasco Signal	355 33 11	2184.2	2388.6	1.35
			184 54 24	Cruger's Wharf	4 54 30	2598.5	2841.6	1 61
Thistle	42 03 26.21	73 56 02.13	0 04 57	Turkey Point, north	180 04 57	4444.9	4860.8	2.76
			0 22 40	Cruger's Wharf	180 22 40	1076.8	1170.5	0.67
Skeel	42 01 47.67	73 56 16.92	189 37 51	Cruger's Wharf	9 38 01	1991.3	2177.6	1.24
			258 29 58	Staats	78 32 11	4656.9	5092.6	2.89
Cruger's Island	42 02 10.09	73 55 20.98	122 36 01	Glasco Signal	302 35 22	1596.5	1745.9	0.99
			143 08 01	Cruger's Wharf	323 07 33	1589.1	1737.8	0.99
Donaldson	41 59 43.52	73 55 41.58	12 30 53	Mills' Wharf	192 30 35	2947.7	3223.5	1 83
			36 48 57	Livingston	216 48 06	2903.4	3175.1	1.80
Rosina	41 59 47.68	73 56 26.12	16 14 30	Livingston	196 14 09	2554.9	2794.0	1.59
			277 07 39	Donaldson	97 08 09	1032.9	1129.5	0.64
Croghan	41 59 25.16	73 56 36.86	245 59 29	Donaldson	66 00 06	1392.5	1522.8	0.86
			199 34 59	Rosina	19 35 06	737.4	806.4	0.46
Delano	41 58 52.01	73 55 50.66	133 54 25	Croghan	313 53 54	1475.9	1614.0	0.92
			18 27 26	Mills' Wharf	198 27 13	1357.5	1484.5	084
Turkey Point, south	42 00 51.20	73 56 03.34	346 30 59	Donaldson	166 31 14	2147.1	2348.0	1.33
			14 58 38	Rosina	194 58 23	2028.6	2218.4	1.26
Goldsmith	41 59 04.58	73 56 46.19	231 03 33	Donaldson	51 04 16	1911 6	2090.5	1.19
			199 09 27	Rosina	19 09 41	1407.6	1539.3	0.87
Hayner	41 58 59 65	73 55 33.86	140 56 26	Rosina	320 55 51	1908.5	2087.1	1 18
			63 08 58	Livingston	243 08 02	2149.4	2350.5	1.33
Delano's House	41 58 45.91	73 55 19.96	106 11 25	Goldsmith	286 10 27	2066.6	2260.0	1.28
			76 15 59	Livingston	256 14 54	2303.5	2519.0	1.43
Railroad Drawbridge	42 01 13.97	73 55 17.07	56 33 45	Turkey Point, south	236 33 14	1275.6	1395.0	0.79
			70 44 24	Turkey Point, north	250 43 54	1105.0	1208.4	0.69
Barker	42 02 34.65	73 54 40.75	92 35 51	Glasco Signal	272 34 45	2272.2	2484.8	1.41
			56 46 26	Skeel	236 45 22	2644.4	2891.8	1.64
Trap Cliff	42 00 23.82	73 55 22.39	154 08 08	Skeel	334 07 28	2875.3	3144.3	1.79
			131 51 50	Turkey Point, south	311 51 23	1265.0	1363.4	0.78
Icehouse Wharf	41 59 56.59	73 56 23.43	239 06 14	Trap Cliff	59 06 55	1636.6	1789.7	1.02
			292 43 57	Donaldson	112 44 25	1044.1	1141.8	0.65
Cramer	42 00 16.22	73 56 20.20	259 59 10	Trap Cliff	79 59 49	1350.8	1477.2	0.84
			6 59 04	Icehouse Wharf	186 59 02	610.0	667.1	0.38
Livingston Island	42 00 53.88	73 55 06.32	101 09 46	Turkey Point, north	281 09 08	1315.3	1438.4	0.82
			152 21 19	Glasco Signal	332 20 30	3625.2	3964.4	2.25
Tillotson's Wharf	42 01 28.50	73 54 52.17	16 57 11	Livingston's Island	196 57 01	1116.5	1221.0	0.69
			63 17 01	Turkey Point, north	243 16 14	1809.1	1978.4	1.12
Magdalen Island	42 02 47.72	73 55 18.02	36 10 44	Skeel	216 10 05	2295.1	2509.8	1.42
			139 29 52	Thistle	319 29 22	1561.5	1707.6	0.97
Glasco Wharf	42 02 20.14	73 56 11.81	284 50 50	Cruger's Island	104 51 24	1209.5	1322.7	0.75
			235 28 29	Magdalen Island	55 29 05	1501.3	1641.8	0.93

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Rhinebeck to Hudson. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Barrytown	41 59 54.83	73 55 39.07	93 03 35	Icehouse Wharf	273 03 05	1022.2	1117.8	0.63
			9 24 57	Donaldson	189 24 55	353.8	386.9	0.22
Sycamore Point	42 03 05.93	73 55 10.81	61 21 10	Glasco Signal	241 20 24	1799 0	1967.3	1.12
			117 55 35	Thistle	297 55 01	1335.5	1460.5	0.83
De Peyster	42 03 48.40	73 55 10.19	0 37 00	Sycamore Point	180 37 00	1310.2	1432.8	0.81
			5 29 25	Magdalen Island	185 29 20	1880.5	2056.5	1.17
Lorillard	42 03 59 26	73 56 14.13	340 03 04	Cruger's Island	160 03 40	3582.6	3917.8	2.23
			282 50 11	De Peyster	102 50 54	1507.4	1648.4	0.94
Railroad, (97)	42 03 58.48	73 55 08.82	5 31 49	Magdalen Island	185 31 43	2193.1	2398 3	1.36
			90 55 36	Lorillard	270 54 52	1501.3	1641.8	0.93
Mynderse	42 04 30.50	73 56 14.96	311 05 30	De Peyster	131 06 13	1975.5	2160.3	1.23
			337 33 36	Magdalen Island	157 34 14	3430.1	3751.1	2.13
Smedberg	42 03 32.47	73 56 11.93	241 02 30	Railroad, (97)	61 03 12	1657.8	1812.9	1.03
			177 46 21	Mynderse	357 46 19	1791.4	1959.0	1.11
Rock Island	42 04 57.34	73 55 46.48	19 31 58	Lorillard	199 31 39	1901.2	2079.1	1.18
			334 30 55	Railroad, (97)	154 31 21	2011.6	2199.8	1.25
Clermont	42 05 01.78	73 54 56.19	83 15 24	Rock Island	263 14 50	1163.8	1272.7	0.72
			61 56 39	Mynderse	241 55 46	2051.4	2243.3	1.27
Railroad, (98)	42 05 27.87	73 54 51.03	8 22 43	Clermont	188 22 40	813.9	890.1	0.51
			8 26 02	Railroad, (97)	188 25 50	2787.8	3048.6	1.73
Malden	42 05 37.30	73 55 35.90	285 45 00	Railroad, (98)	105 45 30	1071.4	1171.6	0.67
			348 27 29	Railroad, (97)	168 27 47	3111.3	3402.4	1.93
Light-house Wharf	42 04 17 27	73 55 28.03	335 16 44	De Peyster	155 16 56	980.6	1072.4	0.61
			62 19 54	Lorillard	242 19 23	1196.4	1308.3	0.74
Stony Point	42 04 08.77	73 56 04.57	283 54 34	Railroad, (97)	103 55 11	1320.2	1443.7	0.82
			252 39 17	Lighthouse Wharf	72 39 41	880.0	962.3	0.55
Frame	42 04 12.16	73 56 23.60	262 57 26	Lighthouse Wharf	82 58 03	1287.0	1407.4	0.80
			283 27 07	Stony Point	103 27 20	449.6	491.7	0.28
Hannah	42 04 24.90	73 56 38.03	319 50 10	Frame	139 50 20	514.3	562.4	0.32
			325 12 26	Lorillard	145 12 42	963.1	1053 2	0.60
Shaler	42 04 24.29	73 56 21.57	7 06 49	Frame	187 06 48	377 3	412.6	0.23
			92 50 01	Hannah	272 49 50	378.9	414.3	0.23
Flats	42 03 58.10	73 55 40.38	42 31 12	Smedberg	222 30 51	1073.0	1173.4	0.67
			269 04 38	Railroad, (97)	89 04 59	725.6	793.5	0.45
Breakwater	42 04 12.61	73 55 42.03	60 50 27	Lorillard	240 50 06	844 9	923.9	0.52
			245 53 55	Lighthouse Wharf	63 54 04	352.4	385.4	0.22
Koones' Island	42 04 22.98	73 55 50.73	288 38 46	Lighthouse Wharf	108 39 01	550 6	602.1	0.34
			327 59 45	Breakwater	147 59 51	377.3	412.6	0.23
Powder-house	42 04 14.50	73 55 55.25	42 42 01	Lorillard	222 41 48	639.8	699 7	0.40
			83 40 07	Frame	263 39 48	655.7	717.0	0.41
Field	42 04 14.26	73 56 19.77	53 41 27	Frame	233 41 24	109.3	119.5	0.07
			344 19 40	Lorillard	164 19 44	480.5	525.5	0.30
Brodhead	42 03 39.29	73 56 15.23	248 47 42	Railroad, (97)	68 48 26	1637.5	1790.7	1 02
			259 20 39	De Peyster	79 21 23	1521.5	1663.9	0.94
Saugerties Light-house	42 04 17.56	73 55 27.93	323 15 20	Railroad, (97)	143 15 33	734 3	803.0	0.46
			208 08 12	Clermont	28 08 33	1547.0	1691.7	0.96
Episcopal Church	42 04 02.61	73 56 35 51	273 39 13	Railroad, (97)	93 40 11	1996.8	2183.6	1.24
			351 57 14	Glasco Signal	171 57 25	2637.1	2883.8	1.64
Roman Catholic Church	42 04 35.36	73 56 27.42	302 11 41	Railroad, (97)	122 12 34	2135.1	2334.9	1.33
			344 39 12	Lorillard	164 39 21	1154.8	1262.8	0.72
Dutch Reformed Church	42 04 39.57	73 56 48.01	327 56 21	Lorillard	147 56 44	1467.3	1604.6	0.91
			299 03 58	Railroad, (97)	119 05 04	2608.4	2852.5	1.62
Methodist Church	42 04 34.63	73 56 37.92	283 35 12	Mynderse	103 35 27	543.4	594.2	0.34
			62 41 05	Mount Paulding	242 39 16	4209.1	4602.9	2.62
Cruger's Summer-house	42 01 39.15	73 55 33 88	29 53 22	Turkey Point, north	209 53 03	1317.2	1440.4	0.82
			149 59 14	Glasco Signal	329 58 43	2095.7	2291.8	1.30
Tivoli Flagstaff	42 03 33.11	73 55 09.11	8 19 18	Magdalen Island	188 19 12	1415.0	1547.4	0.88
			43 34 04	Glasco Signal	223 33 17	2347.2	2566 8	1.46
Barnwell	42 06 14.38	73 54 37.73	49 26 45	Malden	229 26 06	1759 2	1923.8	1.09
			12 01 19	Railroad, 97	192 01 10	1467.0	1604 3	0.91
Egg Island	42 06 17.66	73 55 30.99	274 43 55	Barnwell	94 44 31	1227.7	1342.6	0.76
			329 07 58	Railroad, (98)	149 08 24	1789.6	1957.1	1.11

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Rhinebeck to Hudson. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles*
Ludlow	42 06 39 87	73 54 32.81	8 11 12	Barnwell	188 11 09	794.4	868.7	0.49
			62 52 20	Egg Island	242 51 41	1501.8	1642.3	0.93
Brink's Wharf	42 06 40.87	73 55 15.33	26 40 39	Egg Island	206 40 29	801.2	876.2	0.50
			271 48 42	Ludlow	91 49 11	977.3	1068.7	0.61
Railroad, (101)	42 07 06.10	73 54 17.09	59 48 45	Brink's Wharf	239 48 06	1548.1	1693.0	0.96
			125 13 47	Kortze	305 12 56	2120.4	2318.8	1.32
West Camp	42 07 25.20	73 54 51.50	306 41 24	Railroad, (101)	126 41 47	985.7	1077.9	0.61
			342 56 34	Ludlow	162 56 46	1462.9	1599.8	0.91
East Camp	42 07 43.33	73 53 48.17	30 02 28	Railroad, (101)	210 02 09	1326.7	1450.8	0.82
			68 57 53	West Camp	248 57 11	1558.5	1704.3	0.97
Red House	42 07 55.20	73 54 33.89	345 42 11	Railroad, (101)	165 42 22	1563.2	1709.5	0.97
			289 13 55	East Camp	109 14 25	1112.2	1216.3	0.69
Gould's Wharf	42 08 34 33	73 54 09.19	25 10 26	Red House	205 10 09	1333.7	1458.5	0 83
			342 56 45	East Camp	162 56 59	1646.1	1800.1	1.02
Hog's Back	42 08 51.44	73 53 16.56	19 03 32	East Camp	199 03 11	2223.2	2431.2	1.38
			66 24 38	Gould's Wharf	246 24 03	1318.7	1442.1	0.82
Seward's Island	42 09 57.85	73 53 28.12	352 36 58	Hog's Back	172 37 06	2065.9	2259.2	1.28
			20 05 59	Gould's Wharf	200 05 38	2743.7	3000.4	1.70
Snyder	42 09 11.90	73 53 04 69	159 13 41	Seward's Island	339 13 25	1516.1	1658.0	0.94
			51 57 11	Gould's Wharf	231 56 28	1880.4	2056.4	1.17
Puddecart	42 09 06.71	73 54 01.01	262 55 37	Snyder	82 56 15	1302.8	1424.7	0.81
			294 46 14	Hog's Back	114 46 44	1124.0	1229.2	0.70
Maucus Hook	42 09 54.51	73 53 58.23	310 49 18	Hover	130 50 49	4112.7	4497.5	2.55
			316 56 10	Snyder	136 56 46	1799.4	1967.8	1.12
Wynkoop Hill	42 11 04.91	73 52 32.18	270 23 49	Blue Hill	90 26 28	5421.3	5928.6	3.37
			42 17 00	Maucus Hook	222 16 02	2935.6	3210.3	1.82
Day	42 12 52.64	73 51 13.44	312 55 49	Blue Hill	132 57 35	4936.6	5398.5	3.07
			28 32 03	Wynkoop Hill	208 31 10	3782.8	4136.8	2.35
Eagle's Crag	42 12 11.80	73 52 11.63	226 38 36	Day	46 39 15	1835.2	2006.9	1.14
			293 00 29	Blue Hill	113 02 54	5377.2	5880.3	3.34
Burget	42 13 57.24	73 50 49.16	8 49 36	Big Hill	188 48 23	16249.9	17770.4	10 10
			330 16 50	Blue Hill	150 18 20	6167.0	6744 0	3.83
Railroad, (104)	42 09 49.23	73 52 32.32	101 43 21	Seward's Island	281 42 43	1308.2	1430.6	0.81
			94 44 06	Maucus Hook	274 43 08	1978.3	2163.4	1.23
Perie's Point	42 10 00.40	53 52 18.25	85 29 08	Maucus Hook	265 28 01	2301.7	2517.1	1.43
			87 11 25	Seward's Island	267 10 38	1605.9	1756.2	1.00
Rocliff Jansen Kill	42 10 50.80	73 51 12.27	44 15 06	Perie's Point	224 14 22	2170 6	2373.7	1.35
			103 22 24	Wynkoop Hill	283 21 31	1884 2	2060.5	1.17
John Smith	42 10 08.96	73 51 36.98	168 09 27	Eagle's Crag	348 09 04	3872 5	4234.9	2.41
			143 43 30	Wynkoop Hill	323 42 53	2141.0	2341.3	1.33
Ramshorn Creek	42 11 49.72	73 51 07.16	12 24 52	John Smith	192 24 32	3183.1	3480 9	1.98
			114 44 34	Eagle's Crag	294 43 51	1628.1	1780.4	1.01
Camp Creek	42 10 20.61	73 51 46.69	49 17 54	Perie's Point	229 17 33	955.9	1045.3	0.59
			170 32 22	Eagle's Crag	350 32 05	3477.7	3803.1	2.16
Eiche Hook	42 10 47.02	73 52 23.29	314 06 27	Camp Creek	134 06 52	1170 4	1279.9	0.73
			44 26 59	Seward's Island	224 26 15	2125 2	2324.1	1.32
Wynkoop	42 10 57.57	73 52 05.56	339 11 57	Camp Creek	159 12 09	1219.8	1333.9	0.76
			279 41 29	Roeliff Jansen Kill	99 42 05	1240.4	1356 5	0.77
Fox Creek	42 11 21.61	73 50 47.44	168 00 31	Day	348 00 13	2871.0	3139.6	1.78
			152 26 39	Ramshorn Creek	332 26 26	978.1	1069.6	0.61
Long Dock	42 12 39.02	73 51 05.80	188 58 57	Burget	8 59 08	2443.1	2671.7	1.52
			349 59 55	Fox Creek	170 00 07	2425 0	2651.9	1.51
Decker	42 12 46.10	73 50 23.97	165 15 37	Burget	345 15 20	2269.3	2481.6	1.41
			100 04 47	Day	280 04 14	1152.3	1260.1	0.72
Rodgers' Island, south	42 13 13.94	73 50 32.86	54 46 10	Day	234 45 43	1139.4	1246.0	0.71
			35 02 10	Long Dock	215 01 48	1315.6	1438.7	0.82
Deep Point	42 13 25.51	73 50 55.45	9 23 52	Long Dock	189 23 45	1453.7	1589.7	0 90
			304 34 17	Rodgers' Island, south	124 34 32	628.9	687.7	0.39
Goodes	42 13 59.19	73 50 36.85	356 15 08	Rodgers' Island, south	176 15 11	1399.1	1530.0	0.87
			22 18 25	Deep Point	202 18 13	1123.4	1228.5	0.70
Rodgers' Island, north	42 13 41.52	73 50 21.43	147 03 06	Goodes	327 02 56	649.9	710.7	0.40
			57 39 10	Deep Point	237 38 48	923.1	1009.5	0.57

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson river, from Rhinebeck to Hudson. Sketch B, No. 7.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Lower Red Hook Spire	41 59 28.60	73 52 24.06	171 22 09	Staats	351 21 46	5277.3	5771.1	3.28
			218 54 53	Upper Red Hook	38 56 15	4512.0	4934.2	2.80
Flatbush Spire	42 01 19.84	73 57 00.10	355 23 11	Burhans	175 23 15	1631.7	1784.4	1.01
			141 37 07	Mount Paulding	321 35 33	5201.8	5688.5	3.23
Green	42 03 00.26	73 52 32.41	314 55 52	Upper Red Hook	134 57 20	4275.0	4675.0	2.66
			95 59 35	Mount Paulding	275 55 02	9435.4	10318.3	5.86
Isham	42 05 42.69	73 55 56.39	227 25 17	Ludlow	47 26 13	2507.4	2851.4	1.62
			286 55 35	Railroad, (98)	106 56 19	1569.9	1716.8	0.97
Malden Spire	42 05 46.39	73 55 46.01	281 54 57	Big Hill	101 57 03	4423.4	4837.3	2.75
			184 48 43	Kortze	4 48 51	3695.2	4041.0	2.30
Germantown Spire	42 07 48.66	73 51 58.86	10 46 24	Big Hill	190 45 58	4770.5	5216.9	2.96
			197 16 18	Hover	17 16 29	1249.7	1366.6	0.77
Potts	42 05 39.58	73 50 12.69	78 04 22	Big Hill	258 02 45	3405.1	3723.7	2.12
			1 21 16	Upper Red Hook	181 21 11	7937.0	8679.7	4.93
Mount Merino	42 14 03.05	73 48 43.98	74 44 33	Catskill	254 35 41	18815.4	20576.0	11.69
			68 59 14	Deep Point	248 57 46	3229.8	3532.0	2.01
Fly	42 11 24.76	73 51 24.68	276 27 59	Fox Creek	96 28 24	860.2	940.7	0.53
			48 12 15	Wynkoop	228 11 48	1258.6	1376.4	0.78
Catskill Jail	42 18 00.95	73 51 26.96	34 03 02	Eagle's Crag	214 02 32	1829.9	2001.1	1.14
			309 35 51	Day	129 36 00	402.3	439.9	0.25
Green Point	42 10 26.68	73 52 56.75	312 31 26	Perie's Point	132 31 52	1199.1	1311.3	0.74
			38 59 27	Seward's Island	218 59 06	1144.4	1251.5	0.71
East Camp Hotel, staff	42 07 30.09	73 53 57.96	30 42 09	Railroad, (101)	210 41 56	860.9	941.4	0.53
			133 11 25	Red House	313 11 01	1131.9	1237.8	0.70
Schneider Hill	42 09 03.66	73 52 21.11	321 47 31	Hover	141 47 57	1425.8	1559.2	0.88
			182 08 50	Eagle's Crag	2 08 56	5808.1	6351.6	3.61
Germantown	42 08 09.86	73 53 28.24	29 12 57	East Camp	209 12 44	937.7	1025.4	0.58
			73 18 30	Red House	253 17 46	1573.8	1721.1	0.98
Trumpbour	42 09 39.17	73 54 29.66	236 44 19	Maucus Hook	56 44 40	862.7	943.4	0.54
			225 32 04	Wynkoop Hill	45 33 23	3777.0	4130.4	2.35
Miller	42 11 39.71	73 50 10.87	145 27 14	Long Dock	325 26 37	2221.6	2429.5	1.38
			109 40 54	Eagle's Crag	289 39 33	2941.6	3216.8	1.83
Oak Hill Wharf	42 12 03.46	73 50 40.60	153 35 52	Day	333 35 30	1694.0	1852.5	1.05
			55 10 54	Ramshorn Creek	235 10 36	742.2	811.6	0.46

Section III.—Mouth of Potomac river. Sketch C, No. 9.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Point Lookout	38 02 44.75	76 19 04.90	....	....	....	....	....	....
Hull's Neck	37 56 57.16	76 20 48.81	193 18 03	Point Lookout	13 19 07	11011.8	12042.2	6.84
Cornfield	38 03 11.21	76 21 01.78	285 57 46	Point Lookout	105 58 58	2963.8	3241.1	1.84
			358 25 39	Hull's Neck	178 25 47	11535.9	12615.3	7.17
Point Lookout Light	38 02 15.75	76 19 01.50	174 42 39	Point Lookout	354 42 37	897.7	981.7	0.56
			14 56 11	Hull's Neck	194 55 05	10164.9	11116.0	6.32
Hog Island	38 00 38.82	76 27 19.89	256 08 41	Point Lookout Light	76 13 48	12516.5	13687.7	7.78
			242 58 04	Cornfield	63 01 57	10347.9	11316.1	6.43
George, No. 1	38 06 07.97	76 27 55.18	298 46 58	Point Lookout Light	118 52 27	14847.0	16236.2	9.22
			298 22 31	Cornfield	118 26 46	11453.7	12525.4	7.12
Kit's Point	38 06 09.12	76 24 58.82	89 32 30	George, No. 1	269 30 41	4296.5	4698.5	2.67
			18 40 21	Hog Island	198 38 54	10747.9	11753.6	6.68
Thicket Point	38 01 37.36	76 30 39.00	205 33 43	George, No. 1	25 35 24	9249.1	10114.5	5.75
			290 22 09	Hog Island	110 24 12	5180.5	5665.2	3.22
Lynch's Point	38 02 41.63	76 30 47.36	213 23 43	George, No. 1	33 25 29	7620.6	8333.7	4.73
			306 47 29	Hog Island	126 49 37	6319.0	6910.3	3.93
Sandy Point	38 04 24.09	76 31 48.23	316 41 12	Hog Island	136 43 57	9541.1	10433.9	5.93
			334 50 12	Lynch's Point	154 50 50	3490.0	3816.6	2.17

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section III.—Mouth of Potomac river—St. Mary's river—Curratoman river. Sketch C, No. 9.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Piney Point Light-house Vane..	38 08 03.43	76 31 29.22	304 18 26	George, No. 1..........	124 20 38	6312.5	6903.2	3.92
			3 55 08	Sandy Point......	183 54 57	6777.9	7412.1	4.21
Ragged Point..................	38 08 54.03	76 36 26.82	282 07 26	Piney Point Light-house Vane.	102 10 30	7412.0	8105.5	4.60
			320 46 53	Sandy Point..........	140 49 45	10738.0	11742.8	6.67
Fauntleroy's House	38 01 22.42	76 30 24.61	264 18 28	Point Lookout Light...	84 25 29	16739.2	18305.5	10.40
			256 12 59	Cornfield	76 18 46	14126.8	15448.6	8.78
White Windmill	38 01 21.74	76 30 12.72	264 08 03	Point Lookout Light ...	84 14 56	16452.8	17992.3	10.22
			161 03 49	Lynch's Point	341 03 28	2603.9	2847.5	1.62
Horn Point....................	38 01 40.63	76 32 29.99	233 04 07	Lynch's Point........	53 05 10	3130.2	3423.1	1.94
			272 07 15	Thicket Point..........	92 08 23	2708.9	2961.6	1.68
Windmill, Centre	38 03 33.01	76 21 26.34	318 16 31	Cornfield	138 16 46	902.1	986.5	0.56
			95 59 16	Sandy Point	275 52 53	15240.8	16666.9	9.47
Calvert Bay...................	38 05 25.48	76 23 10.45	347 33 28	Hull's Neck	167 34 55	16047.3	17548.8	9.97
			34 33 12	Hog Island	214 30 38	10727.5	11731.3	6.67
Fish-house, middle of door......	38 03 49 00	76 31 27.95	230 24 51	George, No. 1..........	50 27 02	6725.8	7355.1	4.18
			334 31 20	Lynch's Point	154 31 45	2300.7	2516.0	1.43
St. Mary's river.								
Haywood	38 07 04.06	76 25 35.05	332 28 18	Kit's Point	152 28 40	1910.0	2088.7	1.18
			102 00 41	Piney Point Light-house Vane.	281 57 02	8817.3	9642.3	5.48
Fort Point....................	38 08 04.34	76 26 00.10	341 49 40	Haywood	161 49 56	1955.9	2138.9	1.21
			38 00 34	George, No. 1.........	217 59 23	4552.8	4978.8	2.83
George, No. 2	38 06 12.13	76 27 36.09	271 22 32	Kit's Point	91 24 09	3832.4	4191.0	2.38
			214 02 39	Fort Point............	34 03 38	4175.4	4566.1	2.59
Cecil	38 07 46.39	76 27 20.90	310 53 59	Kit's Point	130 55 26	4578.7	5007.1	2.84
			7 15 57	George, No. 2..........	187 15 47	2929.3	3203.4	1.82
St. Inigo....	38 08 58.73	76 26 12.94	349 26 39	Fort Point............	169 26 47	1705.8	1865.4	1.06
			36 34 26	Cecil	216 33 44	2777.2	3037.1	1.73
Windmill Point................	38 09 26.95	76 26 42.32	338 01 11	Fort Point............	158 01 37	2746.5	3003.5	1.71
			320 33 51	St. Inigo.............	140 34 09	1126.2	1231.6	0.69
Coad	38 08 34.98	76 27 34 66	218 29 23	Windmill Point	38 29 55	2047.2	2238.7	1.27
			249 47 10	St. Inigo	69 48 00	2120.1	2318.5	1.32
Hardy	38 09 30.32	76 25 59.01	19 12 02	St. Inigo	199 11 53	1031.2	1127.7	0.64
			84 22 06	Windmill Point........	264 21 39	1059.5	1158.6	0.66
Chancellor	38 10 02.54	76 26 21.94	330 39 23	Hardy	150 39 37	1139.4	1246.0	0.71
			24 19 [illegible]	Windmill Point........	204 19 21	1204.2	1316.9	0.75
Edwards	38 10 24.94	76 26 46.49	319 07 27	Chancellor	139 07 42	913.1	998.5	0.57
			356 44 50	Windmill Point........	176 44 53	1790.6	1958.1	1.11
Cornfield Tree	38 03 12.70	76 21 02.90	120 01 58	George, No. 2.........	299 57 56	11064.2	12099.5	6.87
			132 31 38	Cecil	312 27 45	12490.6	13659.3	7.76
St. Inigo Windmill	38 08 58.65	76 26 11.86	139 38 46	Windmill Point........	319 38 27	1145.0	1252.1	0.71
			350 17 34	Fort Point............	170 17 41	1698.5	1857.4	1.05
East St. Mary's Point..........	38 11 13.60	76 25 58.63	14 31 01	Chancellor	194 30 47	2263.0	2474.7	1.40
			37 49 23	Edwards	217 48 53	1899.3	2077.0	1.18
West St. Mary's Hill	38 10 51.73	76 26 43.77	238 26 43	East St. Mary's Point...	58 27 11	1288.7	1409.3	0.80
			340 41 44	Chancellor	160 41 57	1606.8	1757.1	1.00
Curratoman river.								
Cabell	37 38 52.59	76 26 54.72	....	....	....	....	....	....
Whiting	37 36 40.18	76 29 50.28	226 30 13	Cabell	46 32 01	5932.0	6487.1	3.68
Chowning Point..........	37 38 50.82	76 29 28.65	7 30 17	Whiting	187 30 04	4062.3	4442.4	2.52
			269 09 41	Cabell................	89 11 15	3773.3	4126.4	2.34
Indiantown	37 39 41.99	76 27 40.92	323 22 04	Cabell................	143 22 32	1897.6	2075.2	1.18
			59 09 25	Chowning Point	239 08 19	3075.6	3363.4	1.91
Ball's Point	37 40 26.29	76 28 36.12	23 37 50	Chowning Point	203 37 18	3212.3	3512.9	2.00
			315 16 18	Indiantown	135 16 52	1922.2	2102.1	1.19
Taylor's Creek	37 40 52.44	76 27 18.70	66 59 01	Ball's Point...........	246 58 14	2061.0	2253.8	1.28
			14 04 31	Indiantown	194 04 17	2239.0	2448.5	1.39
Oak Hill	37 41 43.04	76 28 31.61	2 40 13	Ball's Point	182 40 10	2368.6	2590.2	1.47
			311 07 25	Taylor's Creek........	131 08 10	2371.5	2593.4	1.47
Black Stump.	37 41 35.64	76 27 45.84	101 30 48	Oak Hill	281 30 20	1144.3	1251.4	0.71
			333 27 56	Taylor's Creek	153 28 13	1488.4	1627.7	0.92

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section III.—Curratoman river. Sketch C, No. 9.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
West Point	37 42 09.42	76 28 26.05	316 35 42	Black Stump	136 36 07	1433.6	1567.7	0.89
			9 30 46	Oak Hill	189 30 43	842.6	901.8	0.51
Shelton's Point	37 42 12.16	76 28 52.50	277 29 08	West Point............	97 29 24	653.4	714.5	0.41
			330 20 10	Oak Hill	150 20 26	1033.8	1130.5	0.64
Merry Point	37 42 50.11	76 29 09.46	319 42 17	West Point	139 42 44	1644.2	1798.0	1.02
			340 26 00	Shelton's Point......	160 26 10	1240.7	1356.8	0.77
Ferry Point	37 42 39.60	76 29 21.49	304 24 53	West Point	124 25 27	1646.0	1800.0	1.02
			222 17 56	Merry Point	42 18 03	437.6	478.5	0.27

Section V.—Savannah river to Sapelo sound. Sketch E, No. 16.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
Savannah river to Ossabaw sound.	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Mungen........................	32 04 52.50	80 52 15.63	....	....	....	....	....	....
Tybee Light....................	32 01 21.38	80 50 33.19	157 33 15	Mungen	337 32 21	7035.6	7693.9	4.37
Wilmington	32 00 35.57	80 56 55.36	222 49 18	Mungen	42 51 46	10792.0	11801.8	6.71
			261 57 53	Tybee Light	82 01 15	10127.6	11075.2	6.29
Petit Chou	31 56 42.61	80 55 03.01	157 39 53	Wilmington	337 38 53	7757.1	8482.9	4.82
			219 30 19	Tybee Light	39 32 42	11130.8	12172.3	6.92
Red House, cupola	31 57 17.61	81 00 51.03	225 24 05	Wilmington	45 26 10	8686.0	9498.7	5.40
			276 42 04	Petit Chou	96 45 08	9202.0	10063.0	5.72
South Warsaw	31 52 10.04	80 59 41.32	169 03 49	Red House	349 03 12	9747.8	10550.5	5.99
			221 02 07	Petit Chou	41 04 34	11132.3	12174.0	6.92
Cabbage Island	31 56 23.84	80 58 07.62	263 11 06	Petit Chou	83 12 44	4882.4	5339.3	3.03
			111 06 50	Red House	291 05 24	4599.6	5030.0	2.86
Great Warsaw	31 54 46.44	80 56 08.00	133 40 52	Cabbage Island	313 39 49	4343.7	4750.1	2.70
			205 30 07	Petit Chou	25 30 41	3964.1	4335.0	2.46
Skiddaway......................	31 53 43.51	81 02 31.06	201 43 07	Red House	21 44 00	7098.0	7762.2	4.41
			302 49 25	South Warsaw.........	122 50 55	5308.7	5805.4	3.30
John's Hammock	31 54 24.02	81 00 12.67	348 42 27	South Warsaw.........	168 42 44	4207.5	4601.2	2.61
			71 04 23	Skiddaway	251 03 10	3844.0	4203.7	2.39
Skiddaway Island Base, south end.	31 55 23.15	81 00 52.75	304 42 22	John's Hammock	124 43 15	3198.1	3497.3	1.99
			18 09 47	Skiddaway	198 09 27	3229.6	3531.8	2.01
Skiddaway Island Base, north end.	31 56 08.85	81 01 27.64	328 36 52	John's Hammock....	148 37 32	3782.0	4135.9	2.35
			20 25 07	Skiddaway	200 24 34	4776.3	5223.2	2.97
Romerly Marsh	31 56 03.10	80 59 14.68	26 31 53	John's Hammock	206 31 22	3410.7	3729.8	2.12
			250 03 40	Cabbage Island	70 04 15	1873.1	2048.4	1.16
Blue Flag	31 55 18.70	80 58 17.91	187 40 47	Cabbage Island........	7 40 52	2024.3	2213.7	1.26
			132 31 39	Romerly Marsh	312 31 09	2023.3	2212.6	1.26
Romerly Marsh, (*a*)	31 54 32.26	81 01 04.06	140 47 45	South Base............	320 47 19	2023.1	2212.4	1.26
			168 14 21	North Base..	348 14 09	3038.9	3323.2	1.89
Romerly Marsh, (*a*, 2).....	31 54 33.77	81 00 45.28	130 38 42	South Base............	310 38 06	2335.6	2554.1	1.45
			159 11 49	North Base............	339 11 27	3132.9	3426.0	1.95
Romerly Marsh, (*a*, 3)	31 54 20.29	81 00 55.91	142 22 00	South Base	322 21 30	2444.9	2673.7	1.52
			166 00 11	North Base............	345 59 54	3445.9	3768.3	2.14
Romerly Marsh, (*b*).............	31 54 58.23	81 01 23.82	135 18 06	South Base	315 17 51	1080.1	1181.2	0.67
			177 21 26	North Base............	357 21 24	2177.5	2381.2	1.35
Romerly Marsh, (*c*)	31 54 59.75	81 01 10.46	122 58 57	South Base	302 58 35	1324.1	1448.0	0.82
			168 01 38	North Base............	348 01 29	2175.5	2379.1	1.35
Romerly Marsh, (*d*).............	31 55 10 51	81 01 14.72	111 18 30	South Base........ ...	291 18 10	1072.1	1172.4	0.67
			169 18 15	North Base...........	349 18 08	1828.7	1999.8	1.13
Romerly Marsh, (*e*)	31 55 22.83	81 01 16.11	90 36 03	South Base	270 35 44	962.2	1052.2	0.60
			167 56 28	North Base	347 56 22	1449.5	1585.1	0.90
Romerly Marsh, (*f*)............	31 55 31.38	81 01 17.26	74 47 40	South Base	254 47 21	965.9	1056.3	0.60
			166 42 19	North Base	346 42 13	1185.8	1296.8	0.74
Romerly Marsh, (*f* 2)..........	31 55 40.90	81 00 58.12	69 08 56	South Base	249 08 27	1535.4	1679.1	0.95
			137 59 20	North Base............	317 59 04	1158.6	1267.0	0.72

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Savannah river to Sapelo sound. Sketch E, No. 16.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Romerly Marsh, (*g*)	31 55 44.35	81 00 42.14	70 36 54	South Base	250 36 17	1966.1	2150 1	1.22
			122 16 19	North Base	302 15 55	1413.6	1545.9	0.88
Romerly Marsh, (*h*)	31 55 43.63	81 00 18.57	75 42 14	South Base	255 41 24	2552.8	2791.7	1.59
			113 10 59	North Base	293 10 23	1973.5	2158.2	1.22
Romerly Marsh, (*n*)	31 55 52.62	80 59 01.21	78 37 22	South Base	258 35 51	4595.7	5025.7	2.85
			132 21 54	Romerly Marsh	312 21 47	478.9	523.7	0.30
Romerly Marsh, (*i*)	31 55 49.74	81 00 07.74	73 28 23	South Base	253 27 28	2877.2	3146.4	1.79
			105 40 21	North Base	285 39 39	2179.7	2383.6	1.35
Romerly Marsh, (*k*)	31 55 51.55	80 59 47.82	75 05 20	South Base	255 04 14	3395.8	3713.5	2.11
			101 30 03	North Base	281 29 10	2675.5	2925.8	1.66
Romerly Marsh, (*m*)	31 54 59.49	81 00 21.37	106 53 50	South Base	286 53 02	2508.5	2743.2	1.56
			140 49 42	North Base	320 49 07	2755.8	3013.7	1.71
Waring's Creek Stake	31 56 02.12	81 01 08.64	43 59 44	South Base	223 59 21	1668.0	1824 1	1.04
			112 33 44	North Base	292 33 34	540.6	591.2	0.34
Little Warsaw Island, red flag on north end.	31 54 10.73	81 00 42.74	140 29 55	South Base	320 29 18	2890.7	3161.2	1.80
			242 36 26	John's Hammock	62 36 42	889.7	972 9	0.55
Red Flag on Tree	31 55 28.88	80 59 26.52	196 26 06	Romerly Marsh	16 26 14	1099.1	1201.9	0.68
			230 45 05	Cabbage Island	50 45 47	2676.2	2926.6	1.66
Raccoon Key	31 51 44.05	81 02 45.28	185 47 56	Skiddaway	5 48 04	3698.0	4044.0	2.30
			260 35 09	South Warsaw	80 36 46	4900.9	5359.5	3.04
North Ossabaw, (1)	31 48 53.58	81 02 02.61	167 56 25	Raccoon Key	347 56 03	5368.6	5870.9	3.34
			211 32 06	South Warsaw	31 33 21	7100.6	7765.0	4.41
Morell	31 50 28.51	81 05 15.40	239 28 04	Raccoon Key	59 29 23	4580.8	5009.4	2.85
			299 57 36	North Ossabaw, (1)	119 59 18	5851.8	6399.3	3.63
Green Island	31 53 13 85	81 04 31.09	314 50 13	Raccoon Key	134 51 09	3921.7	4288 6	2.44
			12 53 13	Morell	192 52 50	5223.4	5712.1	3.25
Little Buzzard	31 51 43.31	81 07 29.46	303 09 39	Morell	123 10 50	4210.3	4604.3	2.62
			269 48 17	Raccoon Key	89 50 47	7469.4	8168.3	4.64
Palmetto	31 54 45.66	81 07 26.60	301 30 15	Green Island	121 31 48	5409 4	5915.6	3.36
			0 46 02	Little Buzzard	180 46 00	5616 6	6142.1	3.49
Pryor	31 55 09.62	81 04 49.07	33 34 08	Little Buzzard	213 32 43	7624.5	8337.9	4.74
			79 54 15	Palmetto	259 52 52	4203.5	4596.8	2.61
Ogeechee	31 53 22.42	81 10 12.09	239 27 42	Palmetto	59 29 09	5047.6	5519.9	3.14
			305 31 15	Little Buzzard	125 32 41	5251.9	5743.3	3.26
Chimney of Mill, Hardwick	31 54 25.66	81 13 39.87	266 22 37	Palmetto	86 25 54	9825.4	10744.8	6.10
			289 37 08	Ogeechee	109 38 58	5796.3	6338.7	3.60
Peaked Red Roof, Hardwick	31 54 32.52	81 13 41.40	267 37 09	Palmetto	87 40 27	9854.5	10776.6	6 12
			291 25 15	Ogeechee	111 27 06	5908.0	6460.8	3.67
Cuffee	31 52 48.41	81 09 12.21	306 35 08	Little Buzzard	126 36 02	3363.4	3678.1	2.09
			123 39 11	Ogeechee	303 38 39	1890.3	2067 2	1.17
Call	31 51 38.23	81 09 07.08	151 58 17	Ogeechee	331 57 43	3635.3	3975.5	2.26
			266 30 10	Little Buzzard	86 31 02	2570.6	2811.1	1.60
White Flag at Harvey's Cut	31 54 44.27	81 09 57.90	325 00 05	Little Buzzard	145 01 23	6802.4	7438.9	4.23
			8 24 54	Ogeechee	188 24 46	2548.2	2786.6	1.58
Rogers's Chimney	31 52 13.02	81 10 26.10	240 41 18	Cuffee	60 41 57	2226.6	2434.9	1.38
			297 17 03	Call	117 17 45	2337.0	2555.7	1.45
Dr. Cheves's Mill, chimney	31 55 19.99	81 12 25.16	277 39 18	Palmetto	97 41 54	7933.5	8654.0	4.92
			315 59 47	Ogeechee	136 00 57	5033.4	5504.4	3.13
Great Buzzard Hammock, white flag.	31 52 27.81	81 08 33.45	309 10 53	Little Buzzard	129 11 27	2169.2	2372.2	1.35
			305 11 51	Morell	125 13 36	6371.9	6968.1	3.96
Tree, letter S	31 51 22.72	81 09 52.78	172 09 41	Ogeechee	352 09 31	3721.3	4069.5	2.31
			201 59 56	Cuffee	22 00 17	2846.3	3112.6	1.77
White Flag, Florida Passage	31 50 48.97	81 08 27.72	222 25 47	Little Buzzard	42 26 18	2268.9	2481.2	1.41
			192 25 35	Palmetto	12 26 07	7463 8	8162.2	4.64
White Flag, Little Buzzard Hammock.	31 51 37.03	81 07 23.18	302 07 49	Morell	122 08 56	3966.7	4337.8	2 46
			179 06 58	Palmetto	359 06 56	5810.5	6354.2	3.61
White Flag, Marsh island	31 51 16.48	81 05 45.84	331 33 37	Morell	151 33 53	1680.1	1837.3	1.04
			106 52 56	Little Buzzard	286 52 01	2846.4	3112.7	1.77
White Flag, on creek in marsh	31 52 38.70	81 06 22.85	336 08 24	Morell	156 09 00	4384.0	4794.2	2.72
			249 45 33	Green Island	69 46 32	3130.0	3422.9	1.94
Black Flag, Hell Gate	31 51 55.09	81 04 36.34	21 03 47	Morell	201 03 26	2857.3	3124.7	1.77
			183 15 07	Green Island	3 15 10	2429.4	2656.7	1.51

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Savannah river to Sapelo sound. Sketch E, No. 16.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres*	*Yards.*	*Miles.*
White Flag, below Green island	31 52 32.15	81 04 08.13	24 54 57	Morell	204 54 21	4198.2	4591 0	2.61
			74 08 49	Little Buzzard	254 07 03	5603.5	6127.8	3.48
Black and White Flag, Raccoon Key.	31 50 40.24	81 03 32.60	245 31 11	South Warsaw	65 33 13	6678.7	7303.6	4.15
			324 13 48	North Ossabaw, (1)	141 14 35	4048.3	4427.1	2.51
Egg Island, stake	31 50 25.56	81 04 20.61	93 37 05	Morell	273 36 36	1443.4	1578.5	0.90
			226 01 17	Raccoon Key	46 02 07	3481.8	3807.6	2.16
Pine, Horse Hammock	31 49 32.08	81 03 47.18	233 00 45	South Warsaw	53 02 55	8089.5	8846.4	5.03
			293 18 56	North Ossabaw, (1)	113 19 51	2994.5	3274.7	1.86
White Flag, beach of Ossabaw	31 49 13.33	81 02 51.16	222 30 24	South Warsaw	42 32 04	7384.1	8075.0	4.59
			295 28 16	North Ossabaw, (1)	115 28 42	1414.1	1546.4	0.88
Palm, tuft in tree, Ossabaw	31 48 21.38	81 02 42.25	162 48 11	Bl'k Flag, Raccoon Key.	342 47 44	4476.8	4895.7	2.78
			226 25 47	North Ossabaw, (1)	46 26 08	1438.7	1573.3	0.89
White Flag, Little Ogeechee, opposite Rose Dew.	31 55 00.60	81 08 24.07	346 42 35	Little Buzzard	166 43 04	6243.3	6827.5	3.88
			43 11 32	Ogeechee	223 10 35	4147.1	4535.1	2.58
White Flag, left bank of Little Ogeechee.	31 54 09.41	81 07 44.84	69 30 06	Ogeechee	249 28 48	4130.7	4517.2	2.57
			203 13 41	Palmetto	23 13 51	1215.1	13.8.8	0.75
White Flag, with tuft, Marsh island, on Little Ogeechee river.	31 53 32.04	81 07 22.15	177 02 44	Palmetto	357 02 41	2270.4	2482.8	1.41
			3 16 54	Little Buzzard	183 16 50	3354.0	3667.9	2.08
Possum Island	31 55 18.23	81 06 11.96	276 56 34	Pryor	96 57 18	2193.5	2398.7	1.36
			62 54 28	Palmetto	242 53 49	2202.4	2408.5	1.37
White Flag, Crooked creek	31 54 02.51	81 06 52.38	145 56 01	Palmetto.	325 55 43	1604.7	1754.8	1.00
			12 48 29	Little Buzzard	192 48 09	4396.6	4808.0	2.73
White Flag, with tuft, right bank and mouth of Little Ogeechee river.	31 53 17.32	81 05 36.35	133 12 51	Palmetto	313 11 53	3974.3	4346.2	2.47
			273 33 55	Green Island	93 34 30	1718.4	1879.2	1.07
White Flag, above Green island	31 54 13.83	81 05 34.82	214 58 13	Pryor	34 58 37	2097.1	2293.3	1.30
			33 01 20	Little Buzzard	213 00 19	5528.7	6046.0	3.43
Tall Pine, Petit Guave	31 54 34 86	81 06 51.07	10 48 53	Little Buzzard	190 48 33	5378.7	5882.0	3.34
			109 37 04	Palmetto	289 36 45	991.1	1083.8	0.61
Palmetto, Petit Guave	31 54 56.95	81 06 16.28	79 20 54	Palmetto	259 20 17	1879.5	2055.4	1.17
			260 19 59	Pryor	80 20 45	2323.9	2541.3	1.44
Beaulieu, chimney	31 55 56.22	81 06 36 98	10 02 35	Little Buzzard	190 02 07	7910.4	8650.5	4.91
			50 02 41	Ogeechee	230 00 47	7373.8	8063.8	4 58
Rose Dew, tuft on tree	31 55 53.70	81 07 22.87	1 17 17	Little Buzzard	181 17 14	7713.3	8435.0	4.79
			2 40 25	Palmetto	182 40 23	2097.9	2294.2	1.30
Morell's Chimney, at Montgomery.	31 56 24.73	81 07 03 37	4 32 08	Little Buzzard.	184 31 54	8692.2	9505.5	5.40
			11 16 22	Palmetto	191 16 10	3113.5	3404.8	1.93
Burnside's Island, Brown's chimney.	31 55 37.03	81 05 37.86	61 01 18	Palmetto	241 00 21	3265 2	3570.7	2.03
			22 10 28	Little Buzzard	202 09 29	7772.5	8499.8	4.83
Dead Pine, near Ossabaw	31 50 47.10	81 08 01 37	230 42 37	Green Island	50 44 28	7139.2	7807.2	4.44
			144 17 15	Ogeechee	324 18 24	5889.7	6440.8	3.66
Bird Nest Tree	31 50 40.06	81 06 56.65	174 03 33	Palmetto	354 03 17	7605.0	8316 6	4.72
			218 55 02	Green Island	38 56 19	6088.4	6658.1	3.78
Crooked Top Pine, Green island	31 54 15.35	81 04 33.72	44 36 58	Little Buzzard	224 35 25	6576.7	7192.1	4.09
			79 38 00	Ogeechee	259 35 01	9038.8	9884.6	5.62
Adam's Chimney, Skiddaway	31 53 34.93	81 03 15.30	71 57 04	Green Island	251 56 24	2094.7	2290 7	1.30
			62 47 09	Little Buzzard	242 44 55	7512.1	8215.0	4.67
White Flag, mouth of Adam's creek.	31 52 27.25	81 03) 5 29	338 25 46	Raccoon Key	158 25 57	1430.5	1564.4	0.89
			78 59 30	Little Buzzard	258 57 10	7073 4	7735.3	4.39
Cedar, Raccoon Key	31 51 33.63	81 03 29.00	152 07 54	Green Island	332 07 21	3491.5	3818.2	2.17
			335 15 08	North Ossabaw, (1)	155 15 53	5427.1	5934.9	3.37
White Flag, Flora's hammock	31 52 41.35	81 02 12.30	26 09 44	Raccoon Key	206 09 27	1966 1	2150.1	1 22
			165 33 39	Skiddaway	345 33 29	1976.8	2161.8	1.23
Palmetto, Raccoon Key	31 51 22.78	81 02 45 41	346 13 59	North Ossabaw, (1)	166 14 22	4730.5	5173.1	2.94
			180 14 34	Raccoon Key	0 14 34	655.0	716.3	0.41
Buoy, Egg Island shoal	31 49 48.55	81 03 02.97	230 33 20	South Warsaw	50 35 06	6862.0	7504 1	4.26
			109 28 14	Morell.	289 27 04	3692.4	4037.9	2.29
Fourth Buoy	31 49 35 88	81 02 22.54	221 46 36	South Warsaw	41 48 01	6369.5	6965.5	3.96
			171 26 02	Raccoon Key	351 25 50	3990.9	4364.3	2.48
Third Buoy	31 49 08.67	81 00 58.59	149 37 52	Raccoon Key	329 36 56	5545.8	6064.7	3 44
			199 58 04	South Warsaw	19 58 45	5944.5	6500.7	3.69
Second Buoy	31 48 14.81	80 59 56.33	109 47 11	North Ossabaw, (1)	289 46 05	3529.2	3859.4	2.19
			183 06 59	South Warsaw	3 07 07	7255.5	7931.4	4.51

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Savannah river to Sapelo sound. Sketch E, No. 16.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
White Flag, Pine island	31 51 52.23	81 00 58.45	84 53 10	Raccoon Key	264 52 14	2819.3	3083.1	1.75
			254 50 58	South Warsaw	74 51 39	2099.9	2296.4	1.30
Northernmost Dead Pine	31 52 21.58	81 01 05.40	66 14 35	Raccoon Key	246 13 42	2868.6	3137.0	1.78
			62 06 08	Morell	242 03 56	7436.7	8132.5	4.62
Shanty, Pine island	31 52 16.31	81 00 05.40	286 57 46	South Warsaw	106 57 59	661.4	723.3	0.41
			26 16 38	North Ossabaw	206 15 36	6962.6	7614.1	4.33
Black	31 52 00.71	80 59 16.60	36 48 52	North Ossabaw, (1)	216 47 26	7197.5	7871.0	4.47
			84 37 12	Raccoon Key	264 35 23	5456.4	5967.0	3.39
Wreck	31 49 55.00	80 58 43.32	159 52 01	South Warsaw	339 51 30	4429.7	4844.2	2.75
			117 51 08	Raccoon Key	297 49 00	7192.8	7865.8	4.47
Hopes	31 52 54.09	80 58 10.14	8 59 20	Wreck	188 59 03	5584.1	6106.6	3.47
			47 35 26	Black	227 34 50	2437.0	2665.0	1.51
Beach	31 53 33.85	80 57 06.65	20 39 46	Wreck	200 38 55	7203.1	7877.1	4.48
			50 24 45	Black	230 23 35	4500.1	4921.2	2.80
Odingsell's, chimney	31 53 42.98	81 00 36.93	332 57 05	South Warsaw	152 57 34	3213.7	3514.4	2.00
			42 39 08	Raccoon Key	222 38 00	4979.3	5445.2	3.09
White Flag, southwest of Skiddaway.	31 53 04.41	81 01 19.87	302 52 24	South Warsaw	122 53 16	3084.0	3372.6	1.92
			122 45 57	Skiddaway	302 45 19	2224.8	2433.0	1.38
Pole, with tuft, Odingsell's creek	31 53 12.30	81 00 03.80	173 58 31	John's Hammock	353 58 26	2221.1	2428.9	1.38
			342 52 35	South Warsaw	162 52 47	2006.1	2193.8	1.25
Cedar Tuft	31 57 52.94	80 55 42.08	6 45 43	Great Warsaw	186 45 29	5783.9	6325.1	3.59
			334 39 14	Petit Chou	154 39 35	2396.7	2620.9	1.49
Pine, Doyle's hammock	31 54 16.11	80 58 52.78	196 46 40	Cabbage Island	16 47 04	4108.8	4493.3	2.55
			233 12 02	Petit Chou	53 14 04	7535.3	8240.4	4.68
Pole	31 56 38.59	80 55 21.09	166 28 12	Cedar Tuft	346 28 01	2355.2	2575.6	1.46
			255 23 53	Petit Chou	75 24 03	490.7	536.6	0.30
St. John's Oar	31 57 10.17	80 56 59.91	342 52 36	Great Warsaw	162 53 03	4631.5	5064.9	2.88
			51 15 29	Cabbage Island	231 14 53	2279.7	2493.0	1.42
Pole, northeast point of Great Warsaw.	31 54 29.05	80 55 46.88	133 43 50	Cabbage Island	313 42 36	5114.9	5593.5	3.18
			195 38 45	Petit Chou	15 39 08	4271.7	4671.4	2.65
Eastern Point	31 58 15.21	80 51 14.64	64 34 50	Petit Chou	244 32 49	6639.9	7261.2	4.13
			190 45 03	Tybee Light	10 45 25	5836.1	6382.2	3.62
Pole, with tuft, south side Warsaw island.	31 54 46.63	80 57 11.68	270 11 08	Great Warsaw	90 11 42	1672.7	1829.2	1.04
			223 24 07	Petit Chou	43 25 15	4917.3	5377.4	3.05
Longfellow's Flag Tree	31 55 14.91	80 58 15.68	185 41 44	Cabbage Island	5 41 48	2133.4	2333.0	1.32
			284 38 37	Great Warsaw	104 39 44	3466.6	3791.0	2.15
Walker	31 57 06.45	80 59 04.46	7 50 60	Romerly Marsh	187 50 01	1969.3	2153.6	1.22
			311 19 06	Cabbage Island	131 19 36	1987.5	2173.5	1.23
White Flag in tree, Great Warsaw island.	31 52 51.14	80 58 34.65	138 00 26	John's Hammock	317 59 34	3849.2	4209.4	2.39
			205 59 04	Cedar Tuft	26 00 35	10341.3	11308.9	6.42
White Flag, Whiting Point	31 58 30.28	80 59 34.17	297 21 00	Pole	117 23 14	7482.6	8128.8	4.65
			329 43 33	Cabbage Island	149 44 19	4508.9	4930.8	2.80
Palmetto, near Cabbage island	31 57 30.26	80 57 52.31	11 06 56	Cabbage Island	191 06 48	2084.9	2280.0	1.29
			258 26 28	Cedar Tuft	78 27 37	3489.7	3816.2	2.17
Stump	31 57 14.09	80 57 42.42	286 23 32	Pole	106 24 47	3871.5	4233.8	2.41
			249 15 56	Cedar Tuft	69 17 00	3380.8	3697.1	2.10
Hydrographic Mark	31 56 33.98	80 58 59.90	306 14 58	Great Warsaw	126 16 29	5599.4	6123.3	3.48
			22 11 30	Romerly Marsh	202 11 22	1027.0	1123.1	0.64
Pine of Cabbage Island	31 56 27.48	80 57 40.18	229 40 09	Cedar Tuft	49 41 12	4067.3	4447.9	2.53
			264 38 03	Pole	84 39 17	3668.8	4012.1	2.28
Timberstick	31 58 45.09	80 57 52.22	60 09 19	Red House	240 07 44	5413.1	5919.6	3.36
			295 10 14	Cedar Tuft	115 11 23	3775.2	4128.4	2.34
Dead Tree in hammock, west of Little Tybee.	31 59 06.71	80 55 00.61	12 27 18	Great Warsaw	192 26 42	8209.0	8977.1	5.10
			6 43 23	Pole	186 43 12	4593.5	5023.3	2.85
Chimney of house on Little Tybee.	31 58 09.76	80 54 37.10	22 21 54	Pole	202 21 31	3035.6	3319.6	1.89
			14 13 38	Petit Chou	194 13 24	2769.6	3028.7	1.72
Barrel	31 57 07.28	80 54 02.35	64 30 04	Petit Chou	244 29 32	1764.9	1930.0	1.10
			37 16 20	Great Warsaw	217 15 14	5450.0	5960.0	3.39
Palmetto in hammock, east of Little Tybee.	31 58 16.67	80 53 23.78	41 58 31	Petit Chou	221 57 38	3896.4	4261.0	2.42
			78 37 39	Cedar Tuft	258 36 26	3703.9	4050.5	2.30
White Flag between creeks	31 57 58.31	80 52 42.95	172 50 56	Fort Pulaski	352 50 39	6912.9	7559.7	4.29
			208 34 00	Tybee Light	28 35 09	7121.6	7788.0	4.42

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Ossabaw sound to Sapelo sound. Sketch E, No. 16.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Dead Pine, north end of Little Tybee.	31 59 06.55	80 53 23.69	182 29 39	Fort Pulaski	2 29 43	4761.3	5206.8	2.96
			116 17 26	Wilmington	296 15 34	6195.1	6774.8	3.85
White Flag in cedar, Big Tybee creek.	31 59 37.56	80 52 04.09	153 40 52	Fort Pulaski	333 40 14	4242.0	4638.9	2.64
			103 10 34	Wilmington	283 08 00	7850.5	8585.1	4.88
Cow Horn, Gibson's Cut-off	31 59 35.10	80 54 27.45	205 52 12	Fort Pulaski	25 52 50	4310.2	4713.5	2.68
			115 38 24	Wilmington	295 37 06	4305.8	4708.7	2.67
White Flag, Tybee river, right bank.	32 00 39.88	80 55 28.14	260 36 13	Tybee Light	80 38 49	7846.2	8580.4	4.87
			86 41 55	Wilmington	266 41 09	2291.9	2506.3	1.42
Barn, gable end, Shad's plantation.	32 00 57.39	80 56 54.84	265 45 15	Tybee Light	85 48 37	10042.7	10982.4	6.24
			339 28 48	Petit Chou	159 29 47	8378.2	9162.1	5.21
Flag-staff, Fort Pulaski	32 01 38.70	80 53 15.33	277 08 24	Tybee Light	97 09 50	4288.4	4689.7	2.66
			71 24 11	Wilmington	251 22 14	6091.7	6661.7	3.78
Warsaw Bar Buoy	31 52 45.68	80 52 22.15	149 56 14	Petit Chou	329 54 49	8432.4	9221.4	5.24
			189 54 21	Eastern Point	9 54 57	10302.9	11266.9	6.40
Second Buoy, Warsaw	31 54 35.76	80 53 57.11	95 28 32	Great Warsaw	275 27 23	3454.2	3777.4	2.15
			156 06 32	Petit Chou	336 05 57	4273.0	4672.8	2.65
Ossabaw Sound to Sapelo Sound.								
Cane Patch	31 50 28.68	81 06 15.35	166 10 33	Palmetto	346 09 55	7833.5	8566.5	4.87
			209 49 29	Green Island	29 50 24	5508.6	6024.0	3.42
Sigma	31 51 22.75	81 09 47.62	210 39 21	Palmetto	30 40 35	7265.4	7945.2	4.51
			247 37 11	Green Island	67 39 58	8994.9	9836.5	5.59
Buck Head	31 47 06.42	81 08 11.79	162 18 13	Sigma	342 17 23	8286.8	9062.2	5.15
			205 05 24	Cane Batch	25 06 25	7218.5	7893.9	4.49
Stevenson's Point	31 46 18.02	81 12 16.26	202 36 06	Sigma	22 37 24	10166.7	11118.0	6.32
			256 55 54	Buck Head	76 58 03	6602.1	7219.9	4.10
Newell	31 44 47.51	81 06 55.11	194 54 58	Buck Head	14 55 21	4427.4	4841.7	2.75
			117 47 11	Stevenson's Point	297 45 25	5982.1	6541.8	3.72
Yellow Bluff	31 42 39.75	81 14 06.95	203 25 21	Stevenson's Point	23 26 19	7326.3	8011.8	4.55
			244 21 56	Newell	64 24 40	9102.7	9954.4	5.65
Walburg	31 41 44.30	81 09 02.85	182 04 02	Newell	2 04 06	5646.3	6174.6	3.51
			102 03 38	Yellow Bluff	282 00 58	8186.7	8952.7	5.08
John Thomas	31 38 29.32	81 15 07.19	237 56 15	Walburg	57 59 26	11320.2	12379.4	7.03
			191 37 10	Yellow Bluff	11 37 42	7873.9	8610.7	4.89
English Cut	31 38 21.79	81 10 52.81	147 14 51	Yellow Bluff	327 13 09	9447.6	10331.6	5.87
			204 54 02	Walburg	24 55 00	6876.5	7519.9	4.27
Barbour's Island	31 34 26.95	81 14 23.45	171 09 02	John Thomas	351 08 39	7491.9	8192.9	4.65
			217 43 55	English Cut	37 45 45	9068.6	9917.1	5.63
St. Catherine	31 33 52.79	81 10 47.65	179 03 33	English Cut	359 03 30	8285.2	9060.4	5.15
			141 14 41	John Thomas	321 12 25	10923.4	11945.5	6.79
Moss Island	31 37 38.01	81 12 46.03	23 48 12	Barbour's Island	203 47 21	6363.4	6958.8	3.95
			335 46 02	St. Catherine	155 47 04	7605.4	8317.0	4.72
Raccoon Key, Pine	31 51 22.48	81 04 08.62	253 07 13	Raccoon Key	73 07 57	2289.4	2503.6	1.42
			46 34 04	Morell	226 33 29	2417.4	2643.6	1.50
North Ossabaw, (2)	31 48 53.70	81 02 04.91	120 15 26	Morell	300 13 46	5797.5	6340.0	3.60
			168 33 54	Raccoon Key	348 33 33	5352.9	5853.8	3.33
Small Creek	31 49 43.85	81 04 24.84	218 19 35	Raccoon Key, black and white flag.	38 20 03	2214.3	2421.5	1.37
			290 52 17	Ossabaw Beach, white flag.	110 53 06	2636.5	2883.2	1.64
Bradley	31 48 26.11	81 04 17.29	175 15 38	Small Creek	355 15 34	2402.4	2627.2	1.49
			237 17 14	Ossabaw Beach, white flag.	57 17 59	2692.0	2943.9	1.67
Point	31 49 10.87	81 04 46.68	209 29 10	Small Creek	29 29 22	1166.7	1275.9	0.72
			330 43 16	Bradley	150 43 31	1580.5	1728.4	0.98
Crooked	31 48 08.05	81 05 42.77	317 19 14	Point	37 19 44	2432.9	2660.5	1.51
			356 06 04	Bradley	76 06 49	2316.0	2532.7	1.44
Cedar	31 47 23.95	81 05 10.72	221 10 35	Bradley	41 11 03	2134.4	2334.1	1.32
			191 57 33	Point	11 57 46	3051.3	3336.8	1.89
Scrub	31 47 24.91	81 05 46.48	253 31 35	Cedar	73 31 34	981.0	1072.8	0.61
			231 12 55	Bradley	51 13 42	3009.5	3291.1	1.87
White Flag on Bogging Island	31 49 45.56	81 07 04.10	212 04 23	Green Island	32 05 44	7572.0	8280.5	4.7
			143 30 45	Ogeechee	323 29 06	8307.3	9084.6	5.16

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Ossabaw sound to Sapelo sound. Sketch E, No. **16.**

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
White Flag on Raccoon Island	31 49 49.05	81 07 52.31	189 41 12	Little Buzzard	9 41 24	3570.0	3904.0	2.22
			133 36 04	Sigma	313 35 03	4185.5	4577.1	2.60
Shanghae Pine	31 49 30.09	81 08 02.46	141 27 30	Sigma	321 26 35	4436.2	4851.3	2.76
			48 28 36	Stevenson's Point	228 26 22	8919.1	9753.7	5.54
White Flag, Skipper's Narrows	31 50 28.61	81 10 05.54	24 01 19	Stevenson's Point	204 00 10	8448.5	9239.0	5.25
			349 59 40	Newell	170 00 17	10667.0	11665.1	6.63
Pecksniff	31 49 01.87	81 10 30.00	314 21 17	Buck Head	134 22 30	5084.9	5560.7	3.16
			28 59 25	Stevenson's Point	208 58 29	5768.6	6308.4	3.58
Black and White Flag	31 49 08.47	81 09 23.05	40 58 00	Stevenson's Point	220 56 29	6950.7	7601.1	4.32
			333 29 26	Buck Head	153 30 04	4200.1	4593.1	2.61
Singlestick	31 47 33.21	81 10 10.05	284 50 39	Buck Head	104 51 41	3218.6	3519.8	2.00
			338 52 02	Newell	158 52 41	5470.7	5982.6	3.40
Cross Stick	31 47 55.84	81 11 05.37	329 24 45	Newell	149 25 54	6736.9	7367.3	4.18
			31 45 37	Stevenson's Point	211 45 00	3543.2	3874.7	2.20
White Flag, Kilkenny Creek	31 46 39.25	81 10 48.41	319 05 10	Newell	139 06 10	4552.9	4978.9	2.83
			258 30 17	Buck Head	78 31 40	4204.5	4597.9	2.61
Big Tom	31 46 47.08	81 09 21.20	79 01 02	Stevenson's Point	258 59 30	4691.8	5130.8	2.91
			175 19 23	Sigma	355 19 09	8518.6	9315.7	5.29
Dead Pine	31 45 24.82	81 08 25.63	105 07 32	Stevenson's Point	285 05 31	6285.6	6873.7	3.91
			34 01 37	Newell	214 01 22	1386.2	1515.9	0.81
Milligan's Point	31 43 59.77	81 10 00.46	229 27 44	Newell	49 28 18	2263.1	2474.8	1.40
			340 01 19	Walburg	160 01 49	4439.7	4855.1	2.76
Timmins	31 40 34 19	81 11 53.46	338 35 54	English Cut	158 36 26	4379.4	4789.2	2.72
			53 00 56	John Thomas	232 59 14	6390.0	6987.9	3.97
Medway	31 43 13.41	81 12 07.74	240 13 53	Newell	60 15 34	5840.1	6386.6	3.63
			299 24 01	Walburg	119 25 38	5588.0	6110.9	3.47
Shell Bank	31 45 38.80	81 10 22.04	343 53 45	Walburg	163 54 27	7516.6	8219.9	4.67
			31 51 35	Medway	211 50 39	5271.4	5764.6	3.27
Hart	31 45 19.37	81 12 55.19	342 09 08	Medway	162 09 33	4075.4	4456.7	2.53
			261 32 43	Shell Bank	81 34 04	4074.1	4455.3	2.53
Harris	31 44 10.27	81 14 08.39	222 08 46	Hart	42 09 25	2870.5	3139.1	1.78
			245 23 25	Shell Bank	65 25 24	6551.1	7164.1	4.07
Pine	31 45 51.38	81 15 08.03	333 14 46	Harris	153 15 17	3487.1	3813.4	2.17
			285 44 24	Hart	105 45 34	3631.9	3971.7	2.26
Loan	31 44 05.94	81 15 46.15	267 01 13	Harris	87 02 04	2576 5	2817.6	1.60
			243 17 54	Hart	63 19 24	5035.7	5506.9	3.13
South Ossabaw	31 43 37.47	81 08 05.58	83 23 15	Medway	263 21 08	6417.6	7018.1	3.99
			136 08 46	Shell Bank	316 07 34	5182.7	5667.6	3.22
North Point of St. Catherine	31 41 59.42	81 07 58.93	150 52 15	Shell Bank	330 51 00	7735 5	8459.3	4.80
			164 03 32	Newell	344 03 02	5383.7	5887.4	3.34
North Chimney of C. Rodger's House.	31 47 25.28	81 12 00.84	314 49 19	Newell	134 50 57	6891.3	7536.1	4.28
			275 29 15	Buck Head	95 31 16	6053.3	6619.7	3.76
Dead Creek	31 42 23.09	81 12 43.03	338 39 12	English Cut	158 40 10	7978.2	8724.7	4.96
			27 48 56	John Thomas	207 47 40	8139.2	8900.8	5.06
Jones' Hammock	31 44 28.49	81 12 12.89	118 59 39	Pine	298 58 07	5268.7	5761.7	3.27
			144 36 47	Hart	324 36 25	1922.3	2102.2	1.19
Black Flag on Cedar Point	31 42 24.22	81 10 59.35	216 31 53	Newell	36 32 58	5492.9	6006.9	3.41
			291 50 04	Walburg	111 51 05	3304.7	3613.9	2.05
Range Mark	31 42 07.60	81 08 39.76	175 18 38	Newell	355 18 30	4941.6	5404.0	3.07
			110 19 39	Medway	290 17 50	5838.5	6384.8	3.63
North Buoy, St. Catherine	31 43 07.12	81 08 28.98	91 56 01	Medway	271 54 06	5762.0	6301.1	3.58
			167 27 43	Newell	347 27 29	3168.0	3464.4	1.97
South Buoy, St. Catherine	31 42 32.75	81 08 43.67	103 09 09	Medway	283 07 22	5517.0	6033.2	3 43
			175 50 57	Newell	355 50 51	4160.0	4549.2	2.58
Baker's House, North Chimney	31 43 59.40	81 14 01.96	215 30 00	Hart	35 30 35	3025.6	3308.7	1.88
			153 10 22	Harris	333 10 19	3751.9	4103.0	2.33
White Flag on Marsh Island	31 44 29.16	81 13 31.59	78 35 29	Loan	258 34 18	3613.2	3951.3	2.24
			134 56 32	Pine	314 55 41	3585.2	3920.7	2.23
Sunbury Church	31 45 59.39	81 16 40.90	337 35 03	Loan	157 35 32	3779.5	4133.1	2.35
			309 55 39	Harris	129 56 59	5234.6	5724.4	3.25
Tall White Chimney	31 46 01.47	81 16 34.04	340 29 39	Loan	160 30 04	3774.9	4128.1	2.34
			282 40 16	Hart	102 42 11	5902.7	6455.0	3.67

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Ossabaw sound to Sapelo sound. Sketch E, No. 16.

Name of station.	Latitude.	Longitude.	Azimuth.	To station —	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Chimney on East end of House	31 45 59.07	81 16 36.26	339 15 50	Loan	159 16 16	3725.9	4074.5	2.31
			275 48 51	Pine	95 49 37	2333.2	2551.5	1.45
Scriven's House Chimney	31 46 04.13	81 16 33.51	279 53 50	Pine	99 54 35	2283.4	2497.1	1.42
			312 32 48	Harris	132 34 04	5184.4	5669.5	3.22
White Flag near Yellow Bluff	31 41 53.64	81 14 46.92	271 47 16	Walburg	91 50 17	9063.8	9911.9	5.63
			4 50 46	John Thomas	184 50 35	6315.4	6906.3	3.92
White Flag on left bank of Vandyke Creek.	31 41 13.09	81 12 43.55	260 35 24	Walburg	80 37 20	5890.3	6441.5	3.66
			331 03 13	English Cut	151 04 11	6028.4	6592.5	3.74
Vandyke	31 41 17.83	81 11 34.10	258 25 10	Walburg	78 26 33	4065.4	4445.8	2.53
			348 39 07	English Cut	168 39 29	5529.7	6047.1	3.44
Tall Pine on Moss Island	31 37 45.00	81 12 47.08	218 41 33	Walburg	38 43 31	9444.7	10328.4	5.87
			110 17 50	John Thomas	290 16 37	3935.7	4304.0	2.44
Mrs. Cummings's House, red chimney.	31 41 07.71	81 15 25.45	263 35 25	Walburg	83 38 46	10138.0	11086.6	6.30
			354 21 59	John Thomas	174 22 09	4901.7	5360.3	3.04
Pole near mouth of North Newport River.	31 41 27.53	81 10 10.26	253 46 29	Walburg	73 47 04	1848.5	2021.5	1.15
			11 05 14	English Cut	191 04 52	5829.1	6374.5	3.62
White Flag on right bank of Vandyke Creek.	31 41 04.17	81 14 02.30	261 04 06	Walburg	81 06 43	7982.0	8728.9	4.96
			177 37 12	Yellow Bluff	357 37 10	2945.9	3221.5	1.83
Pole on right bank of North Newport River.	31 39 45.61	81 13 01.60	307 15 15	English Cut	127 16 23	4263.1	4662.0	2.65
			54 37 48	John Thomas	234 36 42	4057.9	4437.6	2.52
Pole near English Cut	31 39 36.18	81 11 43.45	226 58 28	Walburg	46 59 52	5784.6	6325.9	3.59
			69 01 25	John Thomas	248 59 38	5748.6	6286.5	3.57
Stroud	31 39 00.27	81 12 18.02	225 28 54	Walburg	45 30 36	7206.8	7881.1	4.48
			297 49 10	English Cut	117 49 55	2538.9	2776.5	1.58
Pole on left bank of North Newport River.	31 39 53.99	81 14 26.15	296 47 18	English Cut	116 49 10	6296.8	6886.0	3.91
			22 31 25	John Thomas	202 31 03	2822.8	3086.9	1.75
Pole in Marsh, Walburg's Creek	31 40 08.40	81 10 52.86	132 22 46	Yellow Bluff	312 21 04	6917.4	7564.7	4.30
			224 26 17	Walburg	44 27 15	4137.2	4524.3	2.57
Holt	31 40 10.22	81 16 02.48	292 14 28	English Cut	112 17 11	8814.1	9638.8	5.48
			227 35 57	Medway	47 38 01	8369.1	9152.2	5.20
White Flag near Walburg	31 39 47.66	81 09 38.04	74 28 33	John Thomas	254 25 40	9000.6	9842.8	5.59
			126 49 49	Yellow Bluff	306 47 28	8845.2	9672.8	5.50
Black Beard	31 32 00.36	81 11 01.44	130 40 43	Barbour's Island	310 38 58	7022.7	7679.8	4.36
			185 59 50	St. Catherine	5 59 57	3481.9	3807.7	2.16
North Base, Sapelo island	31 31 44.87	81 13 59.78	232 07 15	St. Catherine	52 08 56	6418.4	7019.0	3.99
			172 57 38	Barbour's Island	352 57 26	5091.4	5567.8	3.16
Cedar Hammock	31 33 19.62	81 14 45.08	337 43 46	North Base	157 44 10	3153.1	3448.1	1.96
			260 42 53	St. Catherine	80 44 57	6343.7	6937.3	3.94
Dog Island	31 31 57.66	81 15 49.04	213 45 04	Cedar Hammock	33 45 37	3036.1	3320.2	1.89
			277 46 18	North Base	97 47 15	2909.0	3181.2	1.81
South Base, Sapelo island	31 30 56.01	81 14 29.80	132 14 51	Dog Island	312 14 10	2824.0	3088.2	1.75
			207 45 10	North Base	27 45 26	1700.7	1859.8	1.06
Julienton	31 33 27.75	81 17 55.03	310 47 13	South Base	130 49 00	7151.5	7820.7	4.44
			309 51 09	Dog Island	129 52 15	4328.4	4733.4	2.69
Creighton Island	31 32 03.03	81 18 49.90	271 58 23	Dog Island	91 59 57	4773.3	5219.9	2.97
			209 01 00	Julienton	29 01 29	2983.4	3262.6	1.85
Sutherland	31 32 55.44	81 19 12.69	244 05 13	Julienton	64 05 54	2277.1	2490.2	1.41
			288 19 00	Dog Island	108 20 47	5658.0	6187.4	3.51
Inner Beacon	31 33 01.02	81 10 26.66	113 27 59	Barbour's Island	293 25 55	6806.0	7442.8	4.23
			26 09 01	Black Beard	206 08 46	2081.3	2276.0	1.29
Outer Beacon	31 32 58.23	81 10 00.35	42 06 39	Black Beard	222 06 07	2402.2	2627.0	1.49
			70 20 14	North Base	250 18 09	6707.3	7334.9	4.17
Northeast Point	31 30 41.22	81 09 22.62	133 04 41	Black Beard	313 03 49	3568.5	3902.4	2.22
			158 34 52	Inner Beacon	338 34 19	4624.8	5057.5	2.87
White Flag in tree on east side of St. Catherine's Island.	31 34 32.96	81 09 15.80	55 22 05	North Base	235 19 36	9104.1	9956.0	5.66
			75 26 38	Cedar Hammock	255 23 45	8971.9	9811.4	5.58
White Flag in oak on St. Catherine's Island.	31 33 38.20	81 09 40.87	35 11 52	Black Beard	215 11 10	3687.3	4032.3	2.29
			104 19 38	St. Catherine	284 19 03	1817.5	1987.6	1.13
White Flag on northeast point of Black Beard Island.	31 31 43.65	81 10 31.10	122 43 01	Black Beard	302 42 45	951.4	1040.4	0.59
			173 44 22	St. Catherine	353 44 13	4001.6	4376.0	2.49
White Flag with tuft on east side of Black Beard Island.	31 31 35.62	81 10 46.30	179 31 04	St. Catherine	359 31 03	4225.4	4620.8	2.62
			191 08 35	Inner Beacon	11 08 45	2680.4	2931.2	1.66

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Ossabaw sound to Sapelo sound. Sketch E, No 16.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Inner Buoy, (on bar)...........	31 32 43.23	81 07 14.13	96 10 25	Inner Beacon..........	276 08 44	5107.1	5585.0	3.17
			77 35 49	Black Beard..........	257 33 50	6139.0	6713.4	3.81
Outer Buoy, (on bar)...........	31 32 32.26	81 05 40.88	96 43 20	Inner Beacon..........	276 40 50	7589.0	8299.1	4.71
			83 23 38	Black Beard...........	263 20 50	8511.9	9308 4	5.29
White Flag in pine in hammock on St. Catherine's island.	31 35 05.05	81 10 35.56	8 08 47	St. Catherine	188 08 41	2247.7	2458.0	1.39
			63 45 06	Cedar Hammock.......	243 42 55	7336.9	8023.4	4.56
Kollock's Place, west gable end of house.	31 36 12.11	81 10 36.24	127 44 21	Moss Island	307 43 13	5324.6	4729.2	2.69
			51 00 56	Cedar Hammock.....	230 58 46	8442.2	9232.1	5.25
Tuft in hammock on left bank of South Newport river.	31 36 50.86	81 11 25.70	349 37 45	St. Catherine..........	169 38 05	5574.7	6096.3	3.46
			355 54 34	Black Beard	175 54 47	8969.6	9808.9	5.57
White Flag on marsh at mouth of Wahoo creek.	31 35 32.46	81 11 48.17	48 45 40	Cedar Hammock......	228 44 07	6204.3	6784 8	3.85
			332 31 01	St. Catherine	152 31 33	3459.3	3783.0	2.15
White Flag on shell beach of St. Catherine's island.	31 34 28.03	81 11 06.39	42 19 02	North Base	222 17 31	6794.0	7429.7	4.22
			335 30 24	St. Catherine	155 30 34	1192.3	1303.9	0.74
White Flag at mouth of Johnson's creek.	31 35 31.96	81 10 53.01	357 20 57	St. Catherine	177 21 00	3056.7	3342.7	1.90
			1 57 14	Black Beard	181 57 10	6520.6	7130.7	4.05
White Flag on Wahoo island....	31 36 14.67	81 12 50 66	339 48 10	Black Beard...........	159 49 07	8344.8	9125.6	5.18
			36 55 40	Barbour's Island......	216 54 51	4072.3	4453.3	2.53
White Flag, with tuft, near Oldner's island.	31 34 35.19	81 11 44.03	64 01 35	Cedar Hammock.......	244 00 00	5311.0	5807.9	3.30
			311 16 29	St. Catherine..........	131 16 59	1978.8	2163.9	1.23
White Flag in tree in pine hammock.	31 35 25.07	81 13 26.03	28 20 58	Cedar Hammock	208 20 17	4391.0	4801.9	2.73
			41 13 35	Barbour's Island.......	221 13 05	2296.0	2510.9	1.43
White Flag in pine in hammock on Barbour's Island river.	31 34 41.93	81 13 18.64	76 50 65	Barbour's Island......	256 49 31	1754.7	1918.9	1.09
			41 58 03	Cedar Hammock	221 57 18	3408.9	3727.9	2.12
White Flag on north shore of sound.	31 33 38.11	81 12 36.62	80 28 22	Cedar Hammouk	260 27 15	3435.7	3757.2	2.13
			320 10 15	Black Beard...........	140 11 05	3920.2	4287.0	2.44
White Flag on northwest point of Black Beard island.	31 32 08.68	81 11 54.47	280 23 26	Black Beard..........	100 23 54	1422.0	1555.1	0.88
			208 47 12	St. Catherine..........	28 47 47	3659.0	4001.4	2.27
White Flag in cedar, west side of Black Beard island.	31 31 39.51	81 12 30.02	150 11 07	Barbour's Island.......	330 10 08	6014.6	6577.4	3.74
			232 20 08	Inner Beacon..........	52 21 13	4109.4	4493.9	2.55
White Flag in oak on Black Beard island.	31 31 08.67	81 12 04 78	133 39 27	Cedar Hammock.......	313 38 03	5843.1	6389.8	3.63
			216 47 20	Inner Beacon..........	36 48 11	4321.0	4725.3	2.68
White Flag on northeast point of Sapelo island.	31 31 33.86	81 13 26.75	164 30 26	Barbour's Island.......	344 29 56	5595.7	6119.3	3.48
			147 37 04	Cedar Hammock.......	327 36 23	3857.0	4217.9	2.40
Red and White Flag at mouth of Barbour's Island river.	31 33 18.01	81 13 45.41	52 49 01	Dog Island	232 47 56	4093 4	4476.4	2.54
			91 48 38	Cedar Hammock.......	271 48 07	1574.1	1721.4	0.98
White Flag, with tuft, on Little Mud river.	31 34 16.84	81 15 18.92	333 08 09	Cedar Hammock.......	153 08 27	1975.1	2159.9	1.23
			255 41 08	Barbour's Island	75 41 37	1509.3	1650.5	0.94
White and Black Flag at mouth of Julienton river.	31 33 12.74	81 15 57,04	98 26 59	Julienton..............	278 25 57	3145.5	3439.8	1.95
			263 36 47	Cedar Hammock	83 37 25	1909.2	2087.8	1.18
White Flag on left bank of Julienton river.	31 33 45.61	81 16 36.22	75 09 52	Julienton..............	255 09 11	2149.6	2350.7	1.33
			285 15 39	Cedar Hammock	105 16 37	3037.4	3321.6	1.89
White Flag, with palmetto tuft, in marsh opposite Julienton.	31 32 57.25	81 17 20.06	135 31 54	Julienton..............	315 31 36	1315.9	1439.0	0.82
			307 23 47	Dog Island	127 24 35	3021.2	3303.9	1.88
Black Flag on left bank of Sapelo river.	31 32 45.81	81 16 42.31	316 32 59	Dog Island	136 33 27	2042.9	2234 0	1.27
			251 22 33	Cedar Hammock.......	71 23 34	3262.4	3567.7	2.03
White Flag on Curry Point, Creighton island.	31 29 51.28	81 19 37.10	237 05 05	Dog Island..............	57 07 04	7165.5	7836.0	4.45
			256 09 56	South Base............	76 12 37	8349.8	9131.1	5.19
White and Black Flag on right bank of Sapelo river.	31 31 13.61	81 17 29.38	242 51 08	Dog Island	62 52 00	2974.0	3252.3	1.85
			170 42 21	Julienton..............	350 42 08	4185.7	4577.4	2.60
White Flag on Four-mile Point..	31 32 08.94	81 17 28.12	277 34 20	Dog Island	97 35 12	2636.2	2882.9	1.64
			85 11 24	Creighton Island.......	265 10 41	2164.5	2367.0	1.34
Lower Beacon in Mud river.....	31 31 18.13	81 15 14.47	300 01 43	South Base...........	120 02 06	1361.3	1488.7	0.84
			143 09 25	Dog Island	323 09 07	1521.2	1663.5	0.94
White Flag on left bank of Mud river.	31 31 02 01	81 15 43.41	275 25 55	South Base	95 26 33	1951.1	2133.7	1.21
			175 02 27	Dog Island	355 02 24	1720.2	1881.2	1.07
Beacon at mouth of Teakettle...	31 29 18.65	81 17 28.13	237 29 24	South Base...........	57 30 57	5579.3	6101.4	3.47
			208 05 08	Dog Island	28 06 00	5551.3	6070.7	3.45
Upper Beacon on Mud river	31 29 51.97	81 17 11.70	245 13 00	South Base...........	65 14 25	4704.9	5145.1	2.92
			209 22 51	Dog Island	29 23 34	4443.3	4859.1	2.76
White Flag on creek, Dog Island hammock.	31 30 47.99	81 16 53.78	218 30 26	Dog Island	38 31 00	2742.3	2998 9	1.70
			266 16 30	South Base............	86 17 45	3806.9	4163.1	2.37

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Ossabaw sound to Sapelo sound. Sketch E, No 16.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
White Flag on right bank of Mud river.	31 29 39.93	81 16 19.79	190 49 20 231 04 46	Dog Island .... South Base............	10 49 36 51 05 43	4318.4 3729.9	4722.5 4078.9	2.68 2.32
White Flag on Marsh island, in Mud river.	31 29 13.00	81 18 05.45	240 51 17 215 20 56	South Base............ Dog Island	60 53 10 35 22 07	6514.3 6219.0	7123.8 6800.9	4.05 3.86
Chimney of Mill at west end of Duboy.	31 23 54.08	81 19 30.56	201 25 06 188 06 56	Dog Island .... Julienton..............	21 27 02 8 07 46	15999.4 17886.9	17496.5 19560.6	9.94 11.11
Chimney of Overseer's House, Creighton island.	31 32 01.89	81 18 47.93	271 33 59 207 49 16	Dog Island .... Julienton..............	91 35 33 27 49 44	4720.0 2990.0	5161.6 3269.8	2.93 1.86
White Flag on left bank of Creighton island, Front river.	31 30 31.36	81 18 31.07	238 06 42 189 55 40	Dog Island .... Julienton............	58 08 07 9 55 59	5033.7 5515.1	5504.7 6031.2	3.13 3.43
White Flag, with tuft, in pine centre of Creighton island.	31 31 16.17	81 19 10.45	256 27 28 206 08 36	Dog Island .... Julienton..............	76 29 13 26 09 16	5464.6 4514.6	5975.9 4937.0	3.39 2.80
White Flag on left bank of Sapelo river.	31 32 29.56	81 18 11 66	193 45 36 116 21 07	Julienton.............. Sutherland	13 45 45 296 20 35	1815.1 1796.6	2017.7 1964.7	1.15 1.11
White Flag in tree at Sutherland Bluff.	31 33 06.79	81 19 08.15	292 03 20 346 13 14	Dog Island .... Creighton Island.......	112 05 04 166 13 24	5666.8 2022.0	6197.0 221[illegible].2	3.52 1.26
White Flag in tree on northwest point of Creighton island.	31 31 54.68	81 19 39.85	258 55 59 228 57 24	Creighton Island....... Julienton............	78 56 25 43 58 19	1342.6 3982.4	1468.2 4355.0	0.83 2.47
Black and White Flag on right bank of Sapelo river.	31 32 21.88	81 20 27.69	242 24 21 243 14 54	Sutherland .... Julienton..............	62 25 00 63 16 14	2232.5 4508.6	2441.4 4936.5	1.39 2.80
Gable-end of building at Chocolate.	31 30 01.47	81 15 04.43	184 46 43 144 41 54	Cedar Hammock ...... Julienton.........	4 46 53 324 40 25	6123.9 7784.4	6696.9 8512.8	3.80 4.84

Section V.—Charleston Harbor to Winyah Bay. Sketch E, No. 16.*

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Breach Inlet..................	32 46 19.27	79 48 43.14	....	....	....	....	....	....
Circular Church	32 46 42.54	79 55 39.05	273 45 30	Breach Inlet...........	93 49 15	10846.3	11861.2	6.47
Fort Sumpter, (2)..........	32 45 08.17	79 52 14.51	118 39 15 248 16 33	Circular Church........ Breach Inlet...........	298 37 24 68 18 28	6064.8 5920.5	6632.3 6474.5	3.77 3.68
Venning	32 48 10.67	79 49 22.37	343 26 13 38 33 44	Breach Inlet........... Fort Sumpter, (2)......	163 26 34 218 32 11	3579.9 7187.6	3914.9 7860.1	2.22 4.47
Hamlin	32 49 37.53	79 47 10.69	21 30 15 52 00 45	Breach Inlet........... Venning................	201 29 25 231 59 33	6563.6 4346.1	7177.8 4752.8	4.08 2.70
Goat Island...............	32 48 09.81	79 46 12.61	90 19 21 150 47 52	Venning................ Hamlin................	270 17 39 330 47 21	4936.2 3095.7	5398.1 3385.4	3.07 1.92
Fuller	32 51 05.84	79 45 44.62	7 38 58 39 27 09	Goat Island............ Hamlin................	187 38 43 219 26 22	5471.1 3522.7	5983.0 3852.3	3.40 2.19
Roberts, (2)....................	32 49 43.58	79 43 14.28	122 57 42 88 16 52	Fuller...... .... Hamlin................	302 56 20 268 14 43	4658.5 6151.0	5094.5 6726.5	2.89 3.82
Toomer.........................	32 52 21.74	79 43 59.78	44 28 30 49 23 13	Hamlin................. Fuller	224 26 47 229 22 16	7086.8 3590.7	7749.9 3926.7	4.40 2.23
Capers..........................	32 51 33.28	79 42 11.50	81 20 34 25 47 21	Fuller....... .... Roberts, (2)............	261 18 39 205 46 47	5604.8 3752.7	6129.2 4103.8	3.48 2.33
Pole on Moultrie House.........	32 45 28.55	79 50 51.88	205 00 00 106 58 48	Venning................. Circular Church........	25 00 49 286 56 13	5510.1 7813.2	6025.7 8544.3	3.42 4.85
Sullivan's Island, back beacon..	32 45 39.95	79 51 11.94	211 32 59 106 31 22	Venning................ Circular Church........	31 33 58 285 28 58	5448.2 7213.1	5958.0 7888.0	3.38 4.48
Cator's Landing, (pole).........	32 49 02.76	79 47 46.60	57 13 10 221 05 09	Venning..... .... Hamlin................	237 12 18 41 05 28	2963.2 1420.9	3240.5 1553.8	1.84 0.88
Catholic Church spire, Broad street.	32 46 33.15	79 55 50.75	272 10 04 294 55 31	Breach Inlet........... Fort Sumpter, (2).....	92 13 55 114 57 28	11135.3 6206.4	12177.2 6787.1	6.92 3.86
Dewees	32 50 22.57	79 42 06.20	141 11 42 176 22 52	Toomer .... Capers	321 10 40 356 22 49	4710.9 2182.5	5151.7 2386.7	2.93 1.35

* The positions on Winyah Bay, printed in the report of 1855, require the corrections: — 0″.60 in latitude, and + 4′ 08″.28 in longitude.

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Charleston Harbor to Winyah Bay. Sketch E, No. 16.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Niel	32 50 46.77	79 41 23.91	125 50 14	Toomer	305 48 49	4997.6	5465.2	3.10
			139 11 20	Capers	319 10 44	1893.0	2070.1	1.18
Legare	32 51 01.16	79 40 56.10	56 23 03	Roberts, (2)	236 21 48	4314.9	4718.6	2.68
			117 28 52	Toomer	297 27 12	5381.4	5884.9	3.34
Bar	32 49 15.29	79 41 40.93	162 24 30	Dewees	343 24 16	2174.0	2377.4	1.35
			188 55 35	Niel	8 55 44	2852.4	3119.3	1.77
Point	32 48 39.93	79 42 49.01	161 28 25	Roberts, (2)	341 28 11	2067.8	2261.3	1.28
			238 24 03	Bar	58 24 40	2078.9	2273.4	1.29
Humphries	32 54 54.65	79 40 43.72	20 11 55	Capers	200 11 08	6609.0	7227.4	4.11
			47 15 41	Toomer	227 13 54	6938.6	7587.7	4.31
Jamie	32 53 00.96	79 39 02.90	143 12 35	Humphries	323 11 40	4373.6	4782.8	2.72
			61 09 52	Capers	241 08 10	5596.9	6120.6	3.48
Wagner, (2)	32 57 01.95	79 38 36.98	5 11 14	Jamie	185 11 00	7453.7	8151.1	4.63
			40 01 43	Humphries	220 00 34	5119.9	5599.0	3.18
Middle	32 55 17.69	79 36 03.92	47 50 57	Jamie	227 49 20	6274.6	6861.7	3.90
			128 56 26	Wagner, (2)	308 55 03	5110.6	5588.8	3.17
Owendaw	33 00 24.62	79 34 35.73	13 37 18	Middle	193 36 30	9727.6	10637.8	6.04
			45 06 40	Wagner, (2)	225 04 28	8843.2	9670.7	5.49
Bird Island	32 57 12.82	79 33 28.48	48 42 58	Middle	228 41 34	5373.6	5876.4	3.34
			163 32 30	Owendaw	343 31 53	6160.6	6737.0	3.83
Live Oak	33 03 16.25	79 30 56.30	19 26 44	Bird Island	199 25 21	11871.3	12982.1	7.37
			47 08 16	Owendaw	227 06 16	7769.7	8496.7	4.83
Northeast Bull	32 59 41.82	79 29 22.02	99 13 16	Owendaw	279 10 25	8248.7	9020.5	5.12
			159 41 00	Live Oak	339 40 09	7043.9	7703.0	4.38
Jeremy	33 04 34.98	79 26 01.81	29 55 25	Northeast Bull	209 53 36	10418.2	11393.0	6.47
			72 24 22	Live Oak	252 21 42	8014.2	8764.1	4.98
Cape Roman, old light	33 01 04.97	79 22 13.30	106 38 02	Live Oak	286 33 17	14159.3	15484.2	8.80
			137 31 01	Jeremy	317 28 57	8774.5	9595.5	5.45
Nellie	33 02 23.94	79 26 14.44	44 16 55	Northeast Bull	224 15 13	6974.0	7626.5	4.33
			184 38 25	Jeremy	4 38 32	4050.0	4429.0	2.52
Blake	33 07 58.01	79 20 47.03	9 58 49	Cape Roman, old light	189 58 02	12918.3	14127.1	8.03
			52 33 35	Jeremy	232 30 43	10281.5	11243.5	6.39
Murphy	33 05 57.78	79 19 25.44	76 05 35	Jeremy	256 01 59	10589.6	11580.5	6.58
			150 16 39	Blake	330 15 54	4264.7	4663.7	2.65
Cedar Island, 1857	33 07 55.72	79 14 51.60	42 11 24	Cape Roman, old light	222 07 23	17067.6	18664.6	10.60
			62 55 10	Murphy	244 52 41	7974.2	8720.3	4 95
Rutledge	33 10 27.98	79 18 38.87	35 43 05	Blake	215 41 55	5689.6	6222.0	3.53
			308 31 16	Cedar Island, 1857	128 33 20	7528.5	8232.9	4.68
Cape, (2)	33 01 56.29	79 20 32.73	119 49 22	Jeremy	299 46 23	9836.9	10757.3	6.11
			193 11 51	Murphy	13 12 28	7640.9	8355.8	4.75
Lowndes	33 11 47.51	79 13 36.04	15 20 12	Cedar Island, 1857	195 19 31	7403.8	8096.6	4.60
			72 40 42	Rutledge	252 37 56	8217.3	8986.2	5.10
McConvey	33 10 14.24	79 12 19.61	42 43 03	Cedar Island, 1857	222 40 41	5806.5	6349.8	3.61
			92 29 49	Rutledge	272 26 22	2914.0	3186.7	1.81
South Base, (2)	33 12 33.44	79 11 57.67	7 32 49	McConvey	187 32 37	4325.4	4730.1	2.69
			60 57 31	Lowndes	240 56 37	2914.0	3186.7	1.81
Gibbs	32 53 50.13	79 36 30.09	106 48 21	Humphries	286 46 02	6884.1	7528.9	4.28
			69 07 21	Jamie	249 05 58	4250.6	4648.3	2.64
Vidall's Landing	32 52 13.31	79 40 55.55	183 32 17	Humphries	3 32 23	4979.4	5445.3	3.09
			243 22 09	Jamie	63 23 10	3275.1	3581.5	2.03
Single Palmetto	32 52 52.18	79 41 55.16	266 31 53	Jamie	86 33 27	4485.4	4905.1	2.79
			9 54 47	Capers	189 54 38	2467.0	2697.8	1.53
Edward's, southwest base	32 52 50.01	79 38 42.05	140 32 19	Humphries	320 31 13	4973.6	5439.0	3.09
			180 58 25	Wagner, (2)	0 58 28	7761.7	8487.9	4.82
Johnnie	32 51 38.98	79 39 37.89	199 48 49	Jamie	19 49 08	2683.9	2935.0	1.67
			230 22 08	Gibbs	50 23 50	6336.1	6928.9	3.94
Bruce	32 54 18.00	79 34 18.93	59 26 51	Johnnie	239 23 58	9629.2	10530.2	5.98
			72 11 34	Jamie	252 09 00	7752.0	8477.4	4.82
Vanderhorst	32 57 20.07	79 36 35.89	272 36 49	Bird Island	92 38 31	4872.0	5327.9	3.03
			80 12 55	Wagner, (1)	260 11 49	3202.3	3501.9	1.99
Chimney on west end of small house.	32 58 46.40	79 37 18.84	295 42 52	Bird Island	115 44 57	6639.9	7261.2	4.13
			343 09 21	Middle	163 10 02	6717.1	7345.6	4.17

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Charleston Harbor to Winyah Bay. Sketch E, No. 16.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Dr. Jewey's House, chimney....	32 56 22.27	79 39 17.21	291 35 43	Middle	111 37 28	5400.7	5906.0	3.35
			356 34 04	Jamie	176 34 12	6212.1	6793.4	3.86
Joyce	32 50 02.47	79 41 59.72	173 45 41	Capers	353 45 35	2813.1	3076 3	1.75
			341 25 15	Bar..................	161 25 35	1532.3	1675.7	0.95
Small House, chimney	32 52 34.62	79 43 54.32	305 14 55	Capers	125 15 51	3273.3	3579.6	2.03
			19 39 48	Toomer	199 39 45	421.4	460.8	0.26
Toomer's House, centre........	32 52 47.10	79 45 07.45	296 25 17	Capers	116 26 52	5108.0	5586.0	3.17
			293 56 09	Toomer	113 56 46	1924.5	2104.6	1.19
Hugh	32 51 28.70	79 42 28.75	252 32 01	Capers	72 32 10	470.3	514.3	0.29
			307 26 59	Neil..................	127 27 34	2123.7	2322.4	1.32
Dead Tree on east end of Hammock.	32 49 24.29	79 45 49.40	261 36 54	Roberts, (2)............	81 38 18	4077 6	4459.1	2.53
			67 45 24	Venning................	247 43 28	5985.4	6545.5	3.72
Brick Hammock	32 50 05.39	79 44 42.90	235 28 22	Capers	55 29 44	4777.6	5224.6	2.97
			286 14 37	Roberts, (2)...........	106 15 25	2400.4	2625.0	1.49
Dewees Tripod................	32 50 20.51	79 42 05.41	162 01 36	Dewees	342 01 36	66.8	73.0	0.04
Windmill on Oyster House......	32 47 21.43	79 49 25.91	253 28 45	Goat Island............	73 30 30	5244.9	5735.6	3.26
			46 55 19	Fort Sumpter, (2)......	226 53 48	6008.4	6570.6	3.73
Theodore Wagner's House, centre	32 48 40.42	79 49 19.40	280 58 11	Goat Island............	100 59 52	4949.6	5412.7	3.07
			347 45 21	Breach Inlet...........	167 45 41	4449.1	4865.4	2.76
Hamlin's Old House, centre	32 49 45.92	79 47 14.11	331 37 03	Goat Island............	151 37 37	3365.0	3679.9	2.09
			310 57 11	Hamlin....	160 57 13	273.4	299.0	0.17
Figure Head, Caper's island	32 51 14.74	79 41 40.38	333 33 19	Neil	153 33 28	962.0	1052.0	0.60
			22 40 18	Dewees	202 40 04	1741.4	1904.3	1.08
Legare's House, west chimney..	32 51 28.82	79 42 01.75	322 46 27	Neil..................	142 46 48	1626.5	1778.7	1.01
			3 14 38	Dewees	183 14 36	2043.9	2235.1	1.27
Death, hydrographic signal......	32 49 37.71	79 42 02.84	205 27 07	Neil..........	25 27 28	2355.8	2576.2	1.46
			34 01 15	Point..................	214 00 50	2146.9	2347.8	1.33
Rafe	32 48 51.64	79 42 58.30	250 05 37	Bar	70 06 19	2140.1	2340.3	1.33
			326 10 43	Point..................	146 10 48	434.1	474.7	0.27
Brown	33 13 37.39	79 13 25.96	310 44 53	South Base, (2)........	130 45 41	3017.7	3300.1	1.87
			4 24 39	Lowndes...............	184 24 33	3395.0	3712 7	2.11
Hydrographic Signal...........	33 10 07.51	79 12 18.25	170 21 50	McConvey.......	350 21 49	210.2	229.9	0.13
Hydrographic Signal............	33 11 59.67	79 11 56.03	81 46 30	Lowndes..............	261 45 35	2617.0	2861.9	1.63
			177 39 41	South Base, (2)........	357 39 40	1041.0	1138.4	0.65
Ford's Chimney	33 10 46.80	79 13 27.65	215 20 11	South Base, (2)........	35 21 00	4028.3	4405.2	2.50
			85 54 24	Rutledge	265 51 34	8082 8	8839.1	5.02
Lowndes's Mill	33 11 54.51	79 14 04.96	286 03 27	Lowndes...............	106 03 43	779.6	852.5	0.48
			9 19 56	Cedar Island, 1857	189 19 31	7454.5	8152.0	4.63
Barn......................	33 11 16.76	79 15 06.73	248 00 59	Lowndes	68 01 58	2532.9	2769 9	1.57
			74 42 57	Rutledge	254 41 01	5696.8	6229.8	3.54
Lucas's Mill...................	33 07 57.26	79 16 28.81	212 14 31	Lowndes	32 16 05	8387.2	9172.0	5.21
			144 02 20	Rutledge	324 01 09	5736.8	6273.6	3.56
Ford.............	33 08 55.25	79 13 51.56	40 19 00	Cedar Island, 1857	220 18 27	2405.1	2630.1	1.49
			111 00 59	Rutledge	290 58 22	7973.2	8719.2	4.95
Pole	33 10 26.40	79 16 34.34	303 38 25	Ford	123 39 54	5066 5	5540.6	3.15
			90 52 42	Rutledge	270 51 34	3226.5	3528.4	2.00
Bulow's Mill, chimney	33 11 44.08	79 17 15.58	268 54 55	Lowndes	88 56 55	5685.9	6217.9	3.53
			42 37 10	Rutledge	222 36 24	3185.9	3484.0	1.98
Fanny Meade, chimney of Rice Mill.	33 09 11.78	79 18 36.82	291 51 14	Cedar Island, 1857.....	111 53 17	6289.1	6877.6	3.91
			56 02 45	Blake	236 01 34	4068.4	4449.1	2.53
Lower Mill	33 08 43.72	79 20 29.91	279 32 57	Cedar Island, 1857	99 36 02	8891.8	9723.8	5.52
			221 50 32	Rutledge	41 51 33	4311.7	4715.1	2.68
Upper Mill.....................	33 08 51.80	79 20 42.63	3 56 44	Blake...	183 56 42	1661.2	1816 6	1.03
			339 31 38	Murphy	159 32 20	5721.8	6257.2	3.55
Santee.........................	33 06 39.63	79 17 05.49	70 27 14	Murphy	250 25 58	3850.4	4210.7	2.39
			235 57 23	Cedar Island, 1857.....	55 58 36	4187.9	4579.8	2.60
Horn	33 04 40.84	79 21 21.18	188 17 55	Blake	8 17 36	6137.9	6712.2	3.81
			11 29 36	Cape Roman, old light .	191 29 08	6785.5	7420.4	4.21
Cape Roman, new light	33 01 06.58	79 22 11.88	137 07 14	Jeremy................	317 05 08	8762.6	9582.5	5.44
			189 50 31	Blake..................	9 51 17	12863 5	14067.1	7.99

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Charleston Harbor to Winyah Bay. Sketch E, No. 16.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Ormond Hall, west chimney of house.	33 07 04.26	79 23 18.05	247 03 50	Blake	67 05 13	4250.2	4647.9	2.64
			288 44 22	Murphy	108 46 29	6368.4	6964.3	3.96
Ormond Hall, west apex of barn.	33 07 05.04	79 23 18.83	247 27 57	Blake	67 29 20	4259.5	4658.1	2.65
			288 53 04	Murphy	108 55 11	6395.3	6993.7	3.97
Chimney near Rice Mill, with red roof, (Indian Hill.)	33 09 43.42	79 20 44.88	0 58 35	Blake	180 58 34	3247.8	3551.7	2.02
			343 29 38	Murphy	163 30 21	7249.2	7927.5	4.50
Raccoon Island	33 00 21.59	79 25 47.70	77 35 40	N. E. Bull	257 33 44	5696.1	6229.1	3.54
			177 18 58	Jeremy	357 18 50	7814.3	8545.5	4.85
Leaning Pole	33 00 38.67	79 27 28.04	59 23 07	N. E. Bull	239 22 06	3437.9	3759.6	2.14
			131 56 55	Live Oak	311 55 01	7263.7	7943.3	4.51
Pole, with white flag	33 02 28.39	79 26 23.66	101 47 41	Live Oak	281 45 12	7224.9	7900.9	4.49
			188 16 16	Jeremy	8 16 28	3940.6	4309.3	2.45
Old Mill	33 01 36.08	79 22 17.58	353 22 42	Cape Roman, old light	173 22 44	964.3	1054.5	0.60
			72 18 37	N. E. Bull	252 14 46	11564.0	12646.0	7.18
Moreland's Mill, chimney	33 09 53.40	79 19 54.06	354 09 48	Murphy	174 10 04	7295.8	7978.5	4.53
			12 31 00	Cape Roman, old light	192 29 44	16673.2	18233.3	10.36
South West Cape	33 00 44.01	79 20 36.46	104 25 16	Cape Roman, old light	284 24 23	2594.7	2837.5	1.61
			190 47 08	Murphy	10 47 47	9839.4	10760.1	6.11
North West Cape	33 03 18.15	79 21 19 77	18 42 37	Cape Roman, old light	198 42 08	4330.8	4736.0	2.69
			211 04 50	Murphy	31 05 52	5742.0	6279.3	3.57
White over Blue Flag in marsh	33 03 05.94	79 25 44.58	304 11 27	Cape Roman, old light	124 13 22	6628.3	7248.5	4.12
			92 16 21	Live Oak	272 13 31	8092.6	8849.8	5.03
Eddie	33 01 06.88	79 29 20.14	147 57 24	Live Oak	327 56 32	4701.8	5141.7	2.92
			1 04 12	N. E. Bull	181 04 11	2620.7	2865.9	1.63
Manigault	33 00 25.49	79 34 43.70	277 24 51	Owendaw	97 24 55	208.4	227.9	0.13
Long Hammock	33 02 21.30	79 30 31 91	159 29 58	Live Oak	339 29 45	1807.1	1976.2	1.12
			339 43 53	N. E. Bull	159 44 31	5236.8	5726.8	3.25
Marsh	33 00 58.82	79 30 48.99	177 23 54	Live Oak	357 25 50	4237.5	4634.0	2.63
			316 24 59	N. E. Bull	136 25 46	3274.5	3580.9	2.03
Bull's Island Light	32 55 18 34	79 33 43.65	171 50 48	Owendaw	351 50 20	9531.0	10422.8	5.92
			219 54 50	N. E. Bull	39 57 12	10584.5	11574.2	6.58
Charlie	33 01 24.00	79 32 51.60	55 54 45	Owendaw	235 53 48	3263.3	3568.6	2.03
			220 51 18	Live Oak	40 52 21	4572.1	4999.9	2.84
Petrel Bank	32 59 12.06	79 32 38.15	19 35 24	Bird Island	199 34 57	3898.6	4263.4	2.42
			126 13 20	Owendaw	306 12 16	3782.9	4136.9	2.35
West Chimney of house on main	33 02 01.59	79 34 12.74	352 38 18	Bird Island	172 38 42	8968.7	9807.9	5.57
			11 17 43	Owendaw	191 17 31	3046.0	3331.0	1.89
Summer-house, east apex	32 55 19.81	79 33 38.00	170 55 58	Owendaw	350 55 27	9507.8	10397.4	5.91
			184 03 51	Bird Island	4 03 56	3490.0	3816.6	2.17
Mink Point	32 57 50.88	79 37 59.89	228 12 12	Owendaw	48 14 03	7107.4	7772.4	4.42
			2 9 25 27	Bird Island	99 27 55	7144.8	7813.3	4.44
Shell Signal	32 55 41.09	79 39 39.61	222 04 32	Owendaw	42 07 18	11770.4	12871.8	7.31
			213 08 32	Wagner, (2)	33 09 06	2974.6	3252.9	1.85
Wagner, (1)	32 57 02.39	79 38 37.40	308 57 31	Middle	128 58 54	5127.6	5607.4	3.19
			5 05 39	Jamie	185 05 25	7466.2	8164.8	4.64
Alexander	32 58 03.93	79 36 04.44	64 30 03	Wagner, (1)	244 28 40	4401.4	4813.2	2.74
			207 58 57	Owendaw	27 59 45	4907.5	5366.7	3.05
North Wind	32 53 41.26	79 39 40.52	144 00 27	Humphries	323 59 53	2794.4	3055.8	1.74
			194 49 25	Wagner, (1)	14 49 59	6409.0	7008.7	3.98
Fort Point	32 55 30.54	79 35 47.44	47 14 46	Middle	227 14 37	582.8	637.3	0.36
			228 52 14	Bird Island	48 53 29	4791.2	5239.5	2.98
Post with Cross in water	32 55 58.71	79 35 20.54	231 52 56	Bird Island	51 53 57	3699.5	4045.7	2.30
			41 43 43	Middle	221 43 19	1692.3	1850.6	1.05
Caswell	32 56 21.02	79 36 43.75	252 31 19	Bird Island	72 33 05	5316.6	5814.1	3.30
			332 03 10	Middle	152 03 32	2208.3	2414.9	1.37
Peach Tree	32 54 59.43	79 37 22.02	255 33 18	Middle	75 34 04	2256.3	2467.4	1.40
			34 03 13	Jamie	214 02 22	4404.3	4816.4	2.74
Chimney without house	32 55 55.31	78 39 33.48	215 33 47	Wagner, (2)	35 34 18	2523.2	2759.3	1.57
			2 2 00 02	Middle	102 01 56	5566.0	6086.8	3.46
Family Hydrographic Signal	32 55 47.32	79 34 43.25	108 21 18	Caswell	288 20 13	3297.9	3606.5	2.05
			110 50 07	Wagner, (1)	290 48 00	6506.5	7115.3	4.04

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VI.—St. Mary's river. St. Mary's towards Cedar Keys. Sketch E, No. 20.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Tiger Island Base, south end....	30 41 42.21	81 28 22.70	....	....	....	....	....	....
Tiger Island Base, north end....	30 42 30.20	81 28 48.08	335 26 25	South Base...........	155 26 38	1624.7	1776.7	1.01
Cumberland....................	30 43 23.19	81 27 41.47	19 26 20 47 22 12	South Base .... North Base............	199 25 59 227 21 38	3297.2 2408.8	3605 7 2634.2	2.05 1.50
Point Peter......................	30 43 3?.24	81 30 37.11	314 57 54 275 39 02	South Base............ Cumberland	134 59 03 95 40 32	5054.8 4695.2	5527.8 5134.5	3.14 2.92
Fernandina, geodetic station	30 40 35.24	81 27 42.78	180 23 12 140 33 07	Cumberland .... Point Peter	0 23 13 320 31 38	5171.7 7298.5	5655.6 7981.4	3.21 4.53
Fernandina, astronomical station.	30 40 17.57	81 27 42.78	179 59 57	Fernandina, geodetic station.	359 59 57	544.1	595.0	0.34
Martin's Island................	30 41 15.45	81 30 58.77	233 08 36 187 28 04	Cumberland .... Point Peter...........	53 10 17 7 28 15	6559.7 4434.3	7173 5 4849.2	4.08 2.76
McLure.........................	30 40 55.94	81 26 53.69	95 16 45 164 20 27	Martin's Island .... Cumberland	275 14 40 344 20 02	6549 9 4708.9	7162.8 5149.5	4.07 2.93
Rose's Bluff.....................	30 42 43.58	81 35 00.93	292 49 18 256 29 47	Martin's Island .... Point Peter	112 51 22 76 32 02	6991.5 7217.4	7645.7 7892.7	4.34 4.48
Sand Hill, (1)..................	30 42 18.14	81 27 01.50	152 02 20 97 28 14	Cumberland .... North Base	332 02 00 277 27 20	2267.8 2860.1	2480 0 3127.7	1.41 1.78
Sand Hill, (2)	30 42 11.34	81 27 29.61	171 53 09 105 33 20	Cumberland .... North Base	351 53 03 285 32 40	22 4.8 2167.2	2443.9 2370.0	1.39 1.35
Dufour.........................	30 43 14.70	81 32 55.59	319 44 39 73 58 29	Martin's Island .... Rose's Bluff	139 45 39 253 57 25	4810.8 3469.3	5260.9 3793.9	2.99 2 16
Tiger Island, pine...............	30 42 13.14	81 28 37.67	152 12 03 271 45 06	North Base .... Sand Hill, (2)..........	332 11 57 91 45 40	594.0 1811.7	649.6 1981.2	0.37 1.12
S. E. Point, Cumberland, white flag in tree.	30 43 06.30	81 27 57.59	336 15 28 50 23 55	Sand Hill, (2).......... North Base	156 15 42 230 23 29	1848.9 1743 5	2021.9 1906.6	1.15 1.08
Cumberland, black flag in tree..	30 43 27.56	81 28 20.25	22 44 57 330 08 31	North Base .... Sand Hill, (2)..........	202 44 43 150 08 57	1914.9 2706.2	2094.1 2959.4	1.19 1.68
No. 5, (T. R.)	30 41 44.49	81 28 07.71	142 39 20 230 47 51	North Base .... Sand Hill, (2)..........	322 38 59 50 48 11	1770.8 1308.1	1936.5 1430.5	1.10 0.81
Tiger Island, white flag in tree..	30 41 14.83	81 27 47.67	132 07 54 195 26 10	South Base............ Sand Hill, (2).........	312 07 36 15 26 20	1257.2 1805.0	1374 8 1973.9	0.78 1.12
Pilot Lookout	30 41 24.28	81 27 07.04	105 20 21 157 29 03	South Base .... Sand Hill, (2)..........	285 19 42 337 28 51	2087.9 1568.5	2283.3 1715 3	1.30 0.97
No. 2, (T. R.)..................	30 41 02.52	81 27 49.28	143 57 41 277 47 20	South Base........... McLure...............	323 57 24 97 47 48	1511.6 1493.3	1653.0 1633.0	0.94 0.93
Yellow Bluff, white flag	30 40 36.13	81 27 40.07	150 51 38 243 42 08	South Base............ McLure................	330 51 16 63 42 32	2329.6 1376.9	2547.6 1505.7	1.45 0.85
Yellow Bluff, north gable end of hotel.	30 40 24.63	81 27 39.00	231 21 17 106 24 53	McLure............... Martin's Island.........	51 21 40 286 23 11	1544.0 5542.1	1688.5 6060.7	0 96 3.44
Amelia Light-house	30 40 22.94	81 26 27.04	102 37 23 160 22 08	Martin's Island........ Cumberland	282 35 04 340 21 30	7410.3 5893.1	8103.7 6444.5	4 60 3.66
No. 8, (A.).....................	30 41 28.90	81 26 04.17	52 24 55 16 41 44	McLure................ Amelia Light-house....	232 24 30 196 41 32	1663.3 2120.3	1818.9 2318.7	1.03 1.32
No. 9, (A.).....................	30 40 34.67	81 25 55.10	112 47 41 171 47 01	McLure................ No. 8, (A.)............	292 47 11 351 46 56	1691.4 1687.1	1849.7 1845.0	1.05 1.05
No. 1, Marsh island.............	30 44 58.76	81 29 02.01	323 56 32 45 34 37	Cumberland .... Point Peter...	143 57 13 225 33 48	3640.1 3542.1	3980.7 3873.5	2.26 2.20
Black Flag, Marsh island........	30 44 33.91	81 29 26.36	307 57 44 47 39 39	Cumberland .... Point Peter............	127 58 38 227 39 03	3538.9 2545.8	3870.0 2784.0	2.20 1 58
Black Flag in tree, ocean side, Amelia.	30 40 29.71	81 25 57.20	118 15 27 174 11 42	McLure................ No. 8, (A.)....	298 14 58 354 11 38	1706.9 1832.0	1866.6 2003.4	1.06 1.14
Dungeness.....	30 44 54.03	81 28 09.57	345 01 39 59 15 28	Cumberland .... Point Peter............	165 01 53 239 14 13	2894.5 4566.0	3165.3 4993.2	1.80 2.84
White and Black Flag, ocean side, Cumberland sound.	30 45 31.76	81 29 18.69	30 49 36 351 42 44	Point Peter........... North Base	210 48 56 171 43 00	4070.4 5649.5	4451.3 6178.1	2.53 3 51
White Flag, mouth of St. Mary's river.	30 43 18.36	81 29 58 29	23 02 24 120 39 58	Martin's Island,........ Point Peter............	203 01 53 300 39 38	4112 6 1200.4	4497.4 1312.7	2.55 0.74
Black Flag on Jolly river........	30 42 31.38	81 30 03.86	32 00 18 156 45 00	Martin's Island .... Point Peter........	211 59 50 336 44 43	2757 3 2240.6	3015.3 2450.2	1.71 1.39

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VI.—St. Mary's river. St. Mary's towards Cedar Keys. Sketch E, No. 20.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	Metres.	Yards.	Miles.
White Flag in tree in hammock	30 41 46.27	81 29 40.02	225 36 43	North Base	45 37 10	1933.9	2114.8	1.20
			273 28 26	South Base	93 29 05	2061.3	2254.2	1.28
Woodland's Island, dead tree	30 41 32.74	81 28 51.98	183 21 43	North Base	3 21 45	1772.5	1938.4	1.10
			249 28 33	South Base	69 28 48	832.0	909.9	0.52
Forks of Bell's River, white and black flag.	30 41 18.45	81 29 16.94	88 03 37	Martin's Island	268 02 45	2711.7	2965.4	1.68
			153 38 47	Point Peter	333 38 06	4804.1	5253.6	2.98
Mouth of Bell's River, red flag.	30 40 19.41	81 28 15.60	111 40 51	Martin's Island	291 39 28	4672.9	5110.1	2.90
			175 45 32	South Base	355 45 28	2556.5	2795.7	1.59
Amelia River, red, white, and black flag.	30 39 53.30	81 29 00.35	128 45 20	Martin's Island	308 44 20	4041.6	4419.8	2.51
			196 37 39	South Base	16 37 58	3500.2	3827.7	2.17
Bell's River, black, white, and red flag.	30 40 28.33	81 30 20.40	144 52 23	Martin's Island	324 52 03	1774.2	1940.2	1.10
			234 00 05	South Base	54 01 05	3871.2	4233.4	2.41
Black and White Flag in Palmetto.	30 41 06.03	81 30 29.00	110 06 15	Martin's Island	290 06 00	843.9	922.9	0.52
			251 39 04	South Base	71 40 08	3541.3	3872.7	2.20
Island in Jolly River, red and white flag.	30 42 07.95	81 30 58.72	0 03 28	Martin's Island	180 03 28	1616.6	1767.9	1.00
			123 28 17	Dufour	303 27 17	3727.2	4075.9	2.32
White Flag opposite North River	30 43 20.19	81 31 44.46	342 26 25	Martin's Island	162 26 48	4028.5	4405.4	2.50
			84 54 15	Dufour	264 53 39	1900.2	2078.0	1.18
North River, 1st mill chimney	30 44 05.76	81 32 16.45	287 46 45	Point Peter	107 47 36	2775.4	3035.1	1.72
			338 29 06	Martin's Island	158 29 46	5636.5	6163.9	3.50
North River, 2d mill chimney	30 44 19.64	81 32 19.67	295 02 34	Point Peter	115 03 26	3011.5	3293.3	1.87
			339 12 49	Martin's Island	159 13 30	6066.4	6634.0	3.77
Third Mill, Hall & Temple's	30 44 30.74	81 32 05.09	304 37 45	Point Peter	124 38 30	2844.2	3110.3	1.77
			343 38 38	Martin's Island	163 39 12	6266.7	6853.1	3.89
St. Mary's Presbyterian Church Spire.	30 43 30.40	81 32 46.81	68 00 22	Rose's Bluff	247 59 14	3848.1	4208.2	2.39
			25 48 14	Dufour	205 48 10	537.0	587.2	0.33
Bum's Iron Chimney	30 43 13.01	81 32 44.86	257 07 04	Point Peter	77 08 09	3486.1	3812.3	2.17
			322 02 51	Martin's Island	142 03 45	4590.5	5020.0	2.85
Market-house Bell Tower Staff	30 43 12.42	81 32 49.06	257 13 48	Point Peter	77 14 55	3599.1	3935.9	2.24
			320 49 19	Martin's Island	140 50 15	4645.8	5080.5	2.89
Mill Chimney in St. Mary's	30 43 12.72	81 32 59.27	258 15 11	Point Peter	78 16 24	3862.6	4224.0	2.40
			318 23 23	Martin's Island	138 24 25	4828.8	5280.6	3.00
Jolly River, black and white flag.	30 41 55.70	81 32 13.64	301 52 36	Martin's Island	121 53 14	2346.3	2565.8	1.46
			155 21 30	Dufour	335 21 09	2676.5	2926.9	1.66
Martin's Island, dead tree	30 41 29.27	81 31 21.96	304 35 10	Martin's Island	124 35 22	749.3	819.4	0.47
			142 30 15	Dufour	322 29 27	4091.9	4474.8	2.54
North gable end of Boat-house	30 40 55.12	81 31 31.01	233 53 01	Martin's Island	53 53 17	1062.0	1161.4	0.66
			152 22 02	Dufour	332 21 19	4851.6	5305.6	3.01
Clark's Chimney	30 39 48.28	81 31 19.71	191 43 40	Martin's Island	371 43 51	2741.6	2998.1	1.70
			233 18 45	South Base	53 20 15	5873.8	6423.4	3.65
Cooper's Chimney	30 41 13.25	81 32 53.39	268 43 00	Martin's Island	88 43 58	3051.0	3336.5	1.89
			179 06 15	Dufour	359 06 14	3740.2	4090.2	2.32
Bell's River, white and red flag	30 42 21.75	81 33 24.72	297 42 18	Martin's Island	117 44 32	4387.4	4797.9	2.73
			205 25 04	Dufour	25 25 19	1805.1	1974.0	1.12
St. Mary's Point, black and red flag.	30 42 38.97	81 32 07.81	324 27 27	Martin's Island	144 28 02	3160.3	3456.0	1.96
			130 52 49	Dufour	310 52 25	1681.3	1838.6	1.04
St. Mary's River, black, white and red flag.	30 42 41.11	81 33 45.78	300 40 54	Martin's Island	120 42 19	5167.3	5650.8	3.21
			232 13 33	Dufour	52 13 59	1688.6	1846.6	1.05
Rose's Bluff, black and white flag.	30 42 08.18	81 34 41.95	285 16 34	Martin's Island	105 18 28	6156.8	6732.9	3.83
			234 05 49	Dufour	54 06 43	3493.2	3820.1	2.17
St. Mary's River, white and red flag.	30 43 28.22	81 34 45.68	304 05 20	Martin's Island	124 07 16	7291.4	7973.6	4.53
			278 05 08	Dufour	98 06 04	2958.2	3235.0	1.84
St. Mary's River, whte flag	30 43 31.39	81 34 25.70	307 13 52	Martin's Island	127 15 38	6916.0	7563.1	4.30
			282 05 41	Dufour	102 06 27	2451.7	2681.1	1.52
Dead Tree, on Burwell's creek	30 44 36.17	81 34 34.69	11 23 04	Rose's Bluff	191 22 51	3536.6	3867.5	2.20
			313 34 39	Dufour	133 35 30	3638.9	3979.4	2.26
Black and Red Flag, northeast point of Amelia island.	30 42 07.21	81 26 19.26	106 40 36	Sand Hill, (1)	286 40 14	1173.0	1282.8	0.73
			136 56 09	Cumberland	316 55 27	3202.7	3502.4	1.99
Red Flag, east side of Cumberland island.	30 44 25.98	81 27 34.14	5 46 04	Cumberland	185 45 27	1943.5	2125.3	1.21
			73 12 08	Point Peter	253 10 35	5084.1	5559.8	3.16
Red Flag, on Cumberland sound	30 44 11.91	81 28 53.33	308 07 20	Cumberland	128 07 57	2430.0	2657.4	1.51
			329 02 08	Sand Hill, (2)	149 02 51	4329.6	4734.7	2.6

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VI.—St. Mary's river. St. Mary's, toward Cedar Keys. Sketch E, No. 20.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Bird Nest Tree	30 44 04.02	81 30 35.01	6 56 48	Martin's Island	186 56 36	5229.0	5718.3	3.25
			321 07 06	South Base	141 08 14	5608.5	6133.3	3.48
Red Flag, in hammock, on Tiger island.	30 43 02.09	81 29 29.02	94 03 23	Dufour	274 01 38	5508.9	6024.4	3.42
			121 34 29	Point Peter	301 33 54	2125.7	2324.6	1.32
Prevart's House, west chimney	30 42 05.00	81 34 18.02	286 02 30	Martin's Island	106 04 12	5517.2	6033.4	3.43
			136 08 53	Rose's Bluff	316 08 31	1647.5	1801.6	1.02
White Flag, in tree, above Rose's Bluff.	30 43 03.09	81 34 52.54	20 21 24	Rose's Bluff	200 21 20	640.8	700.7	0.40
			263 26 22	Dufour	83 27 22	3131.9	3424.9	1.95
St. Mary's, toward Cedar Keys.								
Cooper	30 41 34.97	81 34 15.92	279 56 36	Fernandina Geod. Stat'n.	99 59 56	10623.0	11617.0	6.60
			236 52 56	Point Peter	56 54 48	6949.7	7600.0	4.32
O'Niel	30 36 09.69	81 31 51.03	218 55 58	Fernandina Geod. Stat'n.	38 58 04	10514.3	11498.1	6.53
			158 56 54	Cooper	338 55 41	10733.4	11737.7	6.67
Braddock	30 37 03.48	81 38 28.54	218 47 44	Cooper	38 49 53	10728.9	11732.8	6.67
			278 51 52	O'Niel	98 55 14	10715.5	11718.2	6.66
Dunn's Creek	30 31 38.97	81 36 03.58	158 52 42	Braddock	338 51 29	10712.6	11715.0	6.66
			218 53 42	O'Niel	38 55 50	10713.0	11715.4	6.66
Bear Branch	30 32 29.23	81 42 17.31	215 48 11	Braddock	35 50 07	10114.6	11389.1	6.47
			278 48 13	Dunn's Creek	98 51 23	10080.8	11024.1	6.26
Cedar Creek.	30 27 21.27	81 40 01.36	218 56 14	Dunn's Creek	38 58 15	10085.1	11028.8	6.26
			158 54 05	Bear Branch	338 52 56	10065.5	11007.3	6.25
King's Road	30 28 50.51	81 47 26.93	230 46 04	Bear Branch	50 48 41	10653.2	11650.0	6.62
			282 33 52	Cedar Creek	102 37 38	12177.1	13316.5	7.57
Pickett	30 22 23.37	81 44 41.81	218 54 41	Cedar Creek	38 57 03	11910.3	13024.7	7.40
			159 43 40	King's Road	339 42 16	12708.7	13897.8	7.90
Brandy Branch.	30 24 13.78	81 53 57.70	230 42 44	King's Road	50 46 02	13461.5	14724.4	8.37
			282 51 55	Pickett	102 56 36	15223.0	16647.4	9.46
McGirt's Creek.	30 17 14.48	81 50 03.42	222 03 55	Pickett	42 06 37	12815.7	14014.9	7.96
			154 09 42	Brandy Branch	334 07 44	14346.5	15688.9	8.91
Big Creek	30 18 39.14	82 01 56.88	231 07 18	Brandy Branch	51 11 20	16428.2	17965.4	10.21
			277 44 12	McGirt's Creek	97 50 12	19239.4	21039.6	11.95
Padgett	30 11 05.31	81 56 27.23	222 02 47	McGirt's Creek	42 06 00	15313.2	16746.1	9.51
			147 47 10	Big Creek	327 44 24	16520.0	18065.8	10.26

Section VI.—Cape Sable to Matacumba Key. Sketch No. 21.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Cape Sable Base, east end	25 08 27.92	81 00 36.48	....	....	....	....	....	....
Cape Sable Base, west end	25 07 16.04	81 04 12.10	249 52 35	East Base	69 54 07	6431.5	7033.3	4.00
Oyster Key	25 06 09.45	80 57 14.09	126 56 12	East Base	306 54 46	7091 4	7754.9	4.41
			99 56 57	West Base	279 53 59	11887.7	13000.0	7.39
Sandy Key	25 02 02.41	81 00 49.56	181 46 08	East Base	1 46 14	11866.6	12977.0	7.37
			149 32 58	West Base	329 31 32	11194.9	12242.4	6.96
Man-of-war Bush	25 01 52.68	80 54 48.73	152 43 55	Oyster Key	332 42 53	8888.5	9720.2	5.52
			91 43 02	Sandy Key	271 40 29	10118.8	11065.6	6.29
Schooner Bank	24 58 09.86	80 58 34.89	152 11 14	Sandy Key	332 10 17	8090.1	8847.1	5.03
			225 45 20	Man of war Bush	42 46 56	9338.6	10212.4	5.80
Rabbit Key	24 58 46.24	80 49 36.81	107 47 02	Sandy Key	287 42 17	19803.7	21656.7	12 30
			123 16 48	Man of-war bush	303 14 36	10458.5	11437.1	6.50
Horseneck Shoal, east	24 53 17.48	80 51 44.18	128 00 12	Schooner Bank	307 57 19	14618.1	15985.9	9.08
			199 26 51	Rabbit Key	19 27 45	10727.5	11731.3	6.67
Buchanan	24 55 01.53	80 46 50.08	145 57 08	Rabbit Key	325 55 58	8345.4	9126 3	5.18
			68 48 31	Horseneck Shoal, east	248 46 27	8848.5	9676.5	5.50
Twin Keys	24 57 57.22	80 44 40.99	100 19 50	Rabbit Key	280 17 45	8426.3	9214 7	5.24
			33 48 21	Buchanan	213 47 27	6504.7	7113.3	4.04

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VI.—Cape Sable to Matacumba key—Florida reef, from Matacumba to Rodriguez. Sketch No. 21.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back Azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	Metres.	Yards.	Miles.
Lignum Vitæ	24 53 58.06	80 42 17.87	151 22 23	Twin Keys	331 21 21	8383.4	9167.8	5.21
			104 21 24	Buchanan	284 19 29	7884.5	8622.3	4.90
Matacumba	24 50 56.02	80 44 09.76	209 15 07	Lignum Vitæ	29 15 54	6419.5	7020.2	3.99
			149 12 45	Buchanan	329 11 38	8793.1	9615.9	5.46
Centre Key	24 55 47.63	80 49 46.97	182 58 01	Rabbit Key	2 58 05	5502.6	6017.5	3.42
			106 29 41	Schooner Bank	286 25 58	15441.6	16886.5	9.59
Iardella	24 55 59.74	80 48 40.33	162 49 03	Rabbit Key	342 48 39	5362.1	5863.8	3.33
			300 05 45	Buchanan	120 05 31	3571.4	3905.6	2.22
Barnes	24 56 22.80	80 47 26.22	237 52 40	Twin Keys	57 53 50	5464.4	5975.7	3.39
			337 59 40	Buchanan	157 59 55	2697.0	2949.3	1.67
Palm Tree	25 09 36.67	81 07 54.90	319 31 22	Sandy Key	139 34 23	18366.8	20085.4	11.41
			279 44 59	East Base	99 48 05	12458.6	13624.4	7.74
Cape Sable	25 06 53.05	81 04 59.20	275 51 03	Oyster Key	95 54 21	13098.2	14323.8	8.14
			321 57 00	Sandy Key	141 58 46	11353.3	12415.6	7.05
Spoonbill	25 07 22.49	81 00 01.21	7 50 09	Sandy Key	187 49 48	9940.6	10870.7	6.18
			295 37 59	Oyster Key	115 39 10	5192.8	5678.7	3.23
Dorr	25 06 09.42	81 02 37.36	338 18 53	Sandy Key	158 19 39	8178.3	8943.5	5.08
			269 58 25	Oyster Key	90 00 43	9056.2	9903.6	5.63
Curlew	25 07 28.31	80 59 38.42	11 14 48	Sandy Key	191 14 18	10223.3	11179.9	6.35
			300 57 40	Oyster Key	120 58 41	4715.4	5156.6	2.93
Clive	25 04 37.76	80 55 52.16	340 43 17	Man-of-war Bush	160 42 44	5381.2	5884.7	3.34
			60 11 11	Sandy Key	240 09 05	9607 6	10506.6	5.97
Flamingo	25 01 49.19	80 57 08.02	93 45 41	Sandy Key	273 44 07	6223.2	6805.5	3.87
			178 47 00	Oyster Key	358 46 57	8009.3	8758.7	4.97
Blue Bank	24 59 48.78	80 57 01.14	224 13 58	Man-of-war Bush	44 14 54	5321.0	5818.9	3.31
			122 42 59	Sandy Key	302 41 22	7609.8	8321.8	4.73
Oxfoot	24 59 24.33	81 00 21.10	243 53 04	Man-of-war Bush	63 55 25	10376.4	11347.3	6.45
			170 41 15	Sandy Key	350 41 03	4928.8	5390.0	3.06
Jewfish	24 50 31.18	80 47 39.74	262 35 50	Matacumba	82 37 18	5943.6	6499.7	3.69
			234 48 09	Lignum Vitæ	54 50 25	11049.0	12082.8	6.86
Bowlegs Key	24 54 43.07	80 44 37.90	289 24 28	Lignum Vitæ	109 25 27	4166.6	4556.5	2.59
			353 31 32	Matacumba	173 31 44	7031.0	7688.9	4.37
Paola	24 51 14.15	80 44 30.36	150 43 14	Buchanan	330 42 15	8021.8	8772.4	4.98
			216 22 36	Lignum Vitæ	36 23 32	6264.7	6850.9	3.89
Osceola Key	24 51 51.15	80 43 47.05	138 45 00	Buchanan	318 43 43	7792.7	8521.9	4.84
			212 37 46	Lignum Vitæ	32 38 23	4637 2	5071.1	2.88
Florida reef, from Matacumba to Rodiiguez.								
Alligator reef	24 51 01.95	80 37 11.00	89 08 09	Matacumba	269 05 12	11756.8	12856.9	7.30
			122 11 16	Lignum Vitæ	302 09 07	10177.6	11129.9	6.32
Tea Table key	24 53 28.68	80 39 33.33	58 49 12	Matacumba	238 47 16	9069.7	9918.3	5.63
			318 29 22	Alligator Reef	138 30 22	6029.1	6593.2	3.75
Plantation Point	24 57 19.80	80 34 00.70	52 42 08	Tea Table Key	232 39 48	11730.4	12828 0	7.29
			24 39 55	Alligator Reef	204 38 37	12792.3	13989.3	7.95
Crocus Reef	24 54 32.81	80 31 43.02	143 03 41	Plantation Point	323 02 43	6429.2	7030.8	3.99
			81 31 26	Tea Table Key	261 28 08	13342.9	14591.4	8.29
Tavernier Key	24 59 43.81	80 30 20 79	13 32 06	Crocus Reef	193 31 31	9842.8	10763.8	6.12
			54 18 26	Plantation Point	234 16 52	7592.6	8303.0	4.72
Conch Reef	24 57 03.03	80 27 49.99	92 51 46	Plantation Point	272 49 10	10410.9	11385.0	6.47
			139 28 18	Tavernier Key	319 27 16	6509.7	7118.8	4.04
Dove Key	25 02 47.27	80 28 32.26	28 18 42	Tavernier Key	208 18 00	6412.1	7012.1	3.98
			353 35 32	Conch Reef	173 35 50	10659.2	11656.6	6.62
Pickle's Reef	24 59 21.41	80 24 55.65	136 12 49	Dove Key	316 11 11	8776.8	9598.0	5.45
			94 20 39	Tavernier Key	274 18 21	9143.5	9999.1	5.68
Point Charles	25 04 30.43	80 26 38.93	35 11 08	Tavernier Key	215 09 34	10789.3	11798.9	6.70
			343 02 17	Pickle's Reef	163 03 01	9941.1	10871.3	6.18
Dry Rocks	25 02 34.19	80 22 12.64	115 37 09	Point Charles	295 35 16	8277.6	9052.1	5.14
			69 03 53	Tavernier Key	249 00 32	14652.8	16023.9	9.10
French Reef	25 02 05.56	80 21 05.67	95 52 44	Dove Key	275 49 35	12583.9	13761.4	7.82
			115 31 42	Point Charles	295 29 21	10351.4	11320.0	6.43
Indian Key	24 52 34.41	80 40 39.19	231 49 13	Plantation Point	51 52 01	14214.4	15544.4	8.83
			227 53 26	Tea Table Key	47 53 54	2490.4	2723.4	1.55

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VI.—Florida reef, from Matacumba to Rodriguez. Sketch No. 21.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Rodriguez, east	25 02 50.74	80 26 41.73	181 26 25	Point Charles	1 26 26	3068.7	3355.8	1.91
			46 52 26	Tavernier Key	226 50 54	8412.0	9199.1	5.23
Rodriguez, west	25 02 54.29	80 27 46.49	212 35 48	Point Charles	32 36 17	3511.6	3840.2	2.18
			36 25 15	Tavernier Key	216 24 10	7282.8	7964.2	4.52
Wreck Point	25 01 19.91	80 29 44.03	221 28 57	Point Charles	41 30 15	7826.9	8559.3	4.86
			294 15 12	Pickle's Reef	114 17 14	8871.3	9701.4	5 51
Libra	25 00 05.40	80 31 05.43	297 56 57	Tavernier Key	117 57 16	1417.3	1549.9	0.88
			43 57 57	Plantation Point	223 56 43	7078.5	7740.8	4.40
Virgo	24 59 28.52	80 32 07.52	261 03 31	Tavernier Key.	81 04 16	3029.6	3313.1	1.88
			355 39 19	Crocus Reef	175 39 29	9125.1	9978.9	5.67
Taurus	24 58 56.79	80 32 35.66	249 03 14	Tavernier Key	69 04 11	4049.1	4428.0	2.51
			349 40 09	Crocus Reef	169 40 31	8256.2	9028.7	5.13
Leo	24 58 13.14	80 33 10.47	239 36 01	Tavernier Key	59 37 13	5514.7	6030.7	3 43
			340 05 11	Crocus Reef	160 05 40	7210.7	7885.4	4.48
Walker Bank	24 56 44.78	80 34 53.15	233 47 10	Plantation Point	53 47 32	1823.7	1994.3	1.13
			52 25 54	Tea Table Key	232 27 52	9907.2	10834.2	6.16
Old Wreck on Reef	24 52 14.67	80 36 55.65	117 15 05	Tea Table Key	297 13 59	4976.8	5442.5	3.09
			95 32 14	Indian Key	275 30 40	6303.0	6892.8	3.92
Graham	24 56 54.27	80 35 26.62	304 44 04	Crocus Reef	124 45 38	7636.8	8351.4	4.74
			47 34 44	Tea Table Key	227 33 00	9374.8	10252.0	5 82
Bailey	24 56 31.63	80 36 10.92	295 55 07	Crocus Reef	115 57 00	8359 3	9141.5	5.19
			45 15 10	Tea Table Key	225 13 45	7994.1	8742.1	4.97
Dana	24 55 41.23	80 37 12.06	282 49 35	Crocus Reef	102 51 54	9170.0	10356.1	5.88
			359 46 49	Alligator Reef	179 46 49	8592.9	9396.9	5.34
Corwin	24 55 03.62	80 37 50.84	236 59 49	Plantation Point	57 01 26	7695.6	8415.7	4.78
			351 25 43	Alligator Reef	171 26 00	7520.0	8223.6	4.67
Agassiz	24 54 32.03	80 38 25.69	342 00 51	Alligator Reef	162 01 22	6795.9	7431.8	4.22
			44 13 53	Tea Table Key	224 13 25	2719.1	2973.5	1.69
Bowditch Point	24 53 48.38	80 39 30.10	40 24 23	Indian Key	220 23 54	2990.1	3269.9	1.86
			8 21 14	Tea Table Key	188 21 13	611.9	669.1	0.38
Petrel Point	24 53 51.21	80 39 39.44	346 03 13	Tea Table Key	166 03 16	714.4	781.2	0.44
			35 20 17	Indian Key	215 19 52	2896.9	3168.0	1.80
Spring Point	24 52 48.65	80 41 31.14	249 36 29	Tea Table Key	69 37 19	3527.0	3857.0	2.19
			286 49 47	Indian Key	106 50 09	1523.8	1666.4	0.95
Spell Key	24 55 03.39	80 40 16.39	337 26 52	Tea Table Key	157 27 51	3155.4	3450.7	1.96
			7 55 09	Indian Key	187 54 54	4628.1	5061.1	2.88
Stave Point	24 51 40.62	80 42 54.82	239 31 51	Tea Table Key	59 33 16	6560 2	7174.0	4.08
			277 00 35	Alligator Reef	97 03 00	9724.8	10634.7	6.04

Section VII.—Cedar Keys to Homosassa river. Sketch G, No. 23.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Oyster Reef, south, 1856	29 07 24.12	82 59 37.43	92 00 28	Depot Key	271 58 57	5073.3	5548.0	3.15
			150 35 07	Oyster Reef B, (2)	330 34 30	4239.3	4636.0	2.63
Oyster Reef C.	29 08 33.17	82 59 50.55	67 32 54	Depot Key	247 31 29	5102.2	5579.6	3.17
			350 31 38	Oyster Reef, south, 1856.	170 31 44	2155.6	2357.3	1.34
Main Land, 1856	29 10 09.43	82 58 21.85	21 52 18	Oyster Reef, south, 1856.	201 51 41	5484.0	5997.1	3.41
			38 58 31	Oyster Reef C.	218 57 48	3811.3	4167.9	2.37
Main Land, east	29 09 56 00	82 55 27.76	55 17 43	Oyster Reef, south, 1856.	235 15 42	8206 9	8977.0	5.10
			95 02 06	Main Land, 1856.	275 00 41	4721.9	5163.7	2.93
Waccasassa Reef	29 06 39.04	82 55 00.36	139 57 37	Main Land, 1856.	319 55 59	8461.7	9253.4	5.26
			173 02 35	Main Land, east.	353 02 22	6108.5	6680.1	3.79
Grassy Point	29 09 16.89	82 50 52.06	99 12 03	Main Land, east.	279 09 49	7546.4	8252.5	4.69
			54 06 38	Waccasassa Reef	234 04 37	8286.2	9061.5	5.15
Water Signal 1	29 09 40.90	82 59 03.31	231 53 41	Main Land, 1856	51 54 01	1423.5	1556.7	0.88
			31 29 03	Oyster Reef C.	211 28 40	2444.6	2673.3	1.52
Water Signal 2	29 09 39.93	82 58 02.64	54 50 00	Oyster Reef C.	234 49 08	3567 5	3901.3	2.22
			150 15 21	Main Land, 1856.	330 15 12	1045.9	1143.8	0.65

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VII.—Cedar Keys to Homosassa river. Sketch G, No. 23.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ′		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Water Signal 3	29 09 36.55	82 57 10.52	117 42 29	Main Land, 1856	297 41 54	2177.3	2381.0	1.35
			257 49 26	Main Land, east	77 50 16	2840.5	3106.3	1.76
Water Signal 4	29 09 17.99	82 56 12.29	114 20 56	Main Land, 1856	294 19 53	3842.3	4201.8	2.39
			76 50 50	Oyster Reef C	256 49 04	6057.5	6624.3	3.76
Water Signal 5	29 09 12.34	82 55 09.66	108 42 46	Main Land, 1856	288 41 12	5482.0	5995.0	3.41
			160 01 48	Main Land, east	340 01 39	1430.1	1563.9	0.89
Water Signal 6	29 09 01.88	82 54 22.49	13 06 26	Waccasassa Reef	193 06 06	4515.0	4937.5	2.80
			265 20 27	Grassy Point	85 22 09	5705.5	6239.4	3.54
Water Signal 7	29 08 43.90	82 53 36.81	126 31 13	Main Land, east	306 30 19	3730.3	4079.3	2.32
			257 08 24	Grassy Point	77 09 44	4566.5	4993.8	2.84
Water Signal 8	29 08 39.64	82 52 41.47	248 47 46	Grassy Point	68 48 39	3171.3	3468.0	1.97
			117 37 36	Main Land, east	297 36 15	5071.2	5545.7	3.15
Water Signal 11	29 08 55.55	82 50 13.56	122 17 13	Grassy Point	302 16 54	1230.3	1345.4	0.76
			61 33 23	Waccasassa Reef	241 31 03	8818.0	9643.1	5.48
End Mangrove Point	29 06 49.76	82 50 27.93	171 48 46	Grassy Point	351 48 34	4576.3	5004.5	2.84
			87 27 05	Waccasassa Reef	267 21 53	7372.4	8062.2	4.58
West Hydrographic Tripod	29 01 11.76	82 55 50.24	187 37 16	Waccasassa Reef	7 37 40	10165.3	11116.5	6.32
			151 49 30	Oyster Reef, south, 1856.	331 47 40	13005.6	14222.5	8.08
Shellbank 1	29 05 39.02	82 54 24.12	167 44 17	Main Land, east	347 43 46	8 96.0	8853.5	5.03
			152 03 21	Waccasassa Reef	332 03 03	2091.4	2287.1	1.30
Shellbank 2	29 06 18.33	82 54 02.70	161 04 11	Main Land, east	341 03 30	7084.3	7747.2	4.40
			223 08 11	Grassy Point	43 09 44	7534.6	8239.6	4.68
Shellbank 4	29.06.57.38	82 53 29.63	224 44 52	Grassy Point	44 46 09	6048.5	6614.5	3.76
			77 02 27	Waccasassa Reef	257 01 43	2517.3	2752.8	1.56
Northeast Oyster Bar	29 07 17.73	82 54 27.55	161 32 10	Main Land, east	341 31 41	5136.8	5617.4	3.19
			237 46 49	Grassy Point	57 48 34	6883.0	7527.0	4.28
Cormorant Rock	29 06 14.71	82 51 27.92	189 48 02	Grassy Point	9 48 19	5691.5	6224.0	3.54
			136 26 18	Main Land, east	316 24 21	9403.8	10283.7	5.84
Basin Rock	29 02 44.74	82 48 56.74	147 41 54	Cormorant Rock	327 40 41	7648.1	8363.7	4.75
			126 17 06	Waccasassa Reef	306 14 09	12195.2	13336.3	7.58
Middle Marsh	29 04 46.77	82 48 45.20	121 37 01	Cormorant Rock	301 35 42	5165.9	5649.3	3.21
			4 45 10	Basin Rock	184 45 05	3769.4	4122.1	2.34
Turtle Creek	29 07 03.16	82 48 22.30	73 27 35	Cormorant Rock	253 26 05	5234.9	5724.7	3.25
			8 23 29	Middle Marsh	188 23 18	4244.2	4641.3	2.64
Crane Island	29 01 18.35	82 46 36.55	125 02 54	Basin Rock	305 01 46	4632.4	5065.9	2.88
			151 32 04	Middle Marsh	331 31 01	7299.0	7982.0	4.53
Palmetto	29 03 24.44	82 46 59.75	68 53 42	Basin Rock	248 52 45	3392.5	3709.9	2.11
			350 48 56	Crane Island	170 49 07	3932.0	4299.9	2.44
Sand Shoal	28 59 30.84	82 48 08.48	167 39 48	Basin Rock	347 39 25	6110.5	6682.3	3.80
			216 55 30	Crane Island	36 56 15	4140.5	4527.9	2.57
Marsh Island	28 59 07.93	82 45 59.30	101 24 46	Sand Shoal	281 23 43	3566.8	3900.5	2.22
			165 54 33	Crane Island	345 54 15	4139.6	4526.9	2.57
Sand Shoal, (2)	28 59 30.86	82 48 08.16	167 34 53	Basin Rock	347 34 29	6111.7	6683.6	3.80
			216 50 00	Crane Island	36 50 44	4134.6	4521.5	2.57
Half-Moon Bar	28 57 00.24	82 46 15.36	146 33 38	Sand Shoal	326 32 43	5556.1	6076.0	3.45
			186 18 31	Marsh Island	6 18 39	3954.7	4324.7	2.46
Little Island	28 57 07.65	82 43 59.24	138 43 47	Marsh Island	318 42 49	4926.8	5387.8	3.06
			123 10 22	Sand Shoal	303 08 21	8059.4	8813.5	5.01
Crystal Reef	28 54 35.98	82 45 45.97	211 45 11	Little Island	31 46 03	5491.4	6005.2	3.41
			169 50 33	Half-Moon Bar	349 50 19	4511.7	4933.9	2.80
Shell Point	28 55 14.49	82 42 54.52	120 55 02	Half-Moon Bar	300 53 25	6338.5	6931.6	3.94
			75 41 27	Crystal Reef	255 40 04	4792.7	5241.1	2.98
Bear Island	28 52 24.40	82 42 00.76	123 35 41	Crystal Reef	303 33 52	7323.5	8008.8	4.55
			164 27 34	Shell Point	344 27 08	5434.8	5943.3	3.38
Bird Key	28 48 53.12	82 46 06.06	182 57 02	Crystal Reef	362 57 12	10568.9	11557.8	6.57
			225 36 42	Bear Island	45 38 40	9301.0	10171.3	5.78
Waccasassa Point	29 09 31.14	82 49 36.24	77 51 58	Grassy Point	257 54 21	2095.4	2291.5	1.30
			26 32 01	Cormorant Rock	206 31 07	6758.7	7391.1	4.20
Inner Reef	29 07 50.43	82 50 50.66	18 52 10	Cormorant Rock	198 51 52	3114.0	3405.4	1.93
			179 11 07	Grassy Point	359 11 06	2661.8	2910.8	1.65
North Mangroves	29 07 09.66	82 50 30.10	171 22 50	Grassy Point	351 22 39	3961.4	4332.1	2.46
			42 44 30	Cormorant Rock	222 44 02	2303.4	2518.9	1.43

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VII.—Cedar Keys to Homosassa river. Sketch G, No. 23.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ″ ′	*Metres.*	*Yards.*	*Miles.*
Marsh Flag 1	29 08 53.60	82 49 29.71	107 51 59	Grassy Point	267 51 19	2338.0	2556.8	1.43
			171 19 48	Waccasassa Point	351 19 45	1169.0	1278.4	0.73
Marsh Flag 2	29 08 09.92	82 49 25.84	131 30 33	Grassy Point	311 29 51	3111.4	3402.5	1.93
			173 35 25	Waccasassa Reef	353 35 20	2516.3	2751.8	1.56
Marsh Flag 3	29 07 02.27	82 49 02.13	69 37 51	Cormorant Rock	249 36 40	4204.5	4597.9	2.61
			144 21 59	Grassy Point	324 21 06	5099.3	5576.4	3.17
Marsh Flag 4	29 06 26 05	82 49 42.01	160 12 17	Grassy Point	340 11 43	5589.7	6112.7	3.47
			242 03 57	Turtle Creek	62 04 36	2439.0	2667.2	1.51
Shellbank 4, (2)	29 06 57.30	82 53 29.74	291 44 27	Cormorant Rock	111 45 26	3545.9	3877.7	2.20
			77 01 33	Waccasassa Reef	257 00 49	2514.2	2749.5	1.56
North Tripod	29 05 01.39	82 56 17.91	253 54 48	Cormorant Rock	73 57 09	8153.9	8916.9	5.07
			228 11 47	Grassy Point	48 14 25	11805.4	12910.0	7.33
Island Flag	29 03 26.38	82 49 14.66	270 55 56	Palmetto	90 57 01	3649.8	3991.3	2.27
			339 17 16	Basin Rock	159 17 25	1370.5	1498.7	0.85
High Palmetto	29 03 41.28	82 47 08.26	59 19 59	Basin Rock	239 19 06	3412.0	3731.3	2.12
			11 56 13	Sand Shoal	191 55 44	7880.1	8617.4	4.90
East Tripod	29 00 37.89	82 51 33 67	227 22 56	Basin Rock	47 24 12	5768.5	6308.3	3.58
			261 10 28	Crane Island	81 12 52	8135.8	8897.1	5.05
Withlacoochee, bar stake	28 59 48.56	82 48 21.96	287 35 46	Marsh Island	107 36 56	4135.0	4521.9	2.57
			325 53 52	Half-Moon Bar	145 54 55	6256.8	6842.2	3.89
Lone Palmetto	28 59 01.16	82 46 19.55	249 10 29	Marsh Island	69 10 39	586.3	641.2	0.36
			358 15 13	Half-Moon Bar	178 15 15	3724.1	4072.6	2.31
Glassel's Flag	28 59 41.66	82 46 33.39	178 21 06	Crane Island	358 21 04	2977.8	3256.4	1.85
			82 37 15	Sand Shoal, (2)	262 36 29	2586.5	2828 5	1.61
Glassel's Camp	28 59 41.66	82 46 33.92	145 34 17	Basin Rock	325 33 08	6833.9	7473.3	4.25
			82 35 12	Sand Shoal	262 34 26	2581.0	2822.5	1.60
High Reef	28 55 33.00	82 45 15.74	25 00 39	Crystal Reef	205 00 24	1937.0	2118.2	1.20
			278 27 59	Shell Point	98 29 07	3866.8	4228 6	2 40
Shell Island Tripod	28 55 36.56	82 42 38.55	113 42 14	Half-Moon Bar	293 40 29	6411.4	7011.3	3.98
			69 50 25	Crystal Reef	249 48 51	5408.1	5914.1	3.36
Marsh Point A, flag	28 56 03.26	82 43 06.38	58 08 41	Crystal Reef	238 07 24	5089.3	5565.5	3.16
			347 55 34	Shell Point	167 55 40	1535.3	1679.0	0.95
Marsh Point B, flag	28 54 45.89	82 42 38.21	86 34 50	Crystal Reef	266 33 19	5095.0	5571.7	3.17
			153 21 01	Shell Point	333 20 52	985.1	1077.3	0.61
Marsh Point C, flag	28 54 03.57	82 42 21.39	100 13 19	Crystal Reef	280 11 40	5630 8	6157.7	3.50
			157 39 26	Shell Point	337 39 10	2360.6	2581.5	1.47
Mangrove Point	28 52 22.00	82 44 42.04	157 13 29	Crystal Reef	337 12 58	4473 6	4892.2	2.78
			208 44 11	Shell Point	28 45 03	6056.3	6623.0	3.76
Oyster Bar 1	28 53 39.01	82 45 53.70	186 48 07	Crystal Reef	6 48 11	1766.4	1931.7	1.10
			238 47 10	Shell Point	58 48 37	5674.1	6205.0	3.53
Oyster Bar 2	28 52 44.92	82 46 01.02	186 47 51	Crystal Reef	6 47 58	3443.1	3765.3	2.14
			227 38 31	Shell Point	47 40 01	6835.5	7475.1	4.25
Green Point	28 50 59.41	82 44 50.74	167 21 05	Crystal Reef	317 20 38	6832.8	7472 1	4.24
			240 23 30	Bear Island	60 24 52	5297.4	5793.1	3.29
Middle Mangrove	28 50 49.13	82 45 05.37	171 03 03	Crystal Reef	351 02 43	7069.5	7731.0	4.39
			239 36 30	Bear Island	59 37 59	5799.2	6341.8	3.60
Mullet Key	28 52 55.51	82 42 26.99	119 51 31	Crystal Reef	299 49 55	6214 8	6796.3	3.86
			323 25 03	Bear Island	143 25 16	1192.5	1304 1	0.71

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VIII.—Chandeleur Sound. Sketch H, No. 26.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards*	*Miles.*
South Point	30 11 21.25	W. 1 04 36.19	63 07 23	Bayou Pierre, 1852	243 03 22	14354.4	15697.5	8.92
			128 55 23	Cat Island Light	308 53 31	7613.7	8326.1	4.73
Door Point	30 03 13.54	1 07 24.84	135 47 37	Bayou Pierre, 1852	315 45 02	11889.7	13002.2	7.39
			196 43 11	South Point	16 44 36	15680.4	17147.6	9.74
Sandfly	30 00 08.18	1 13 51.74	188 15 27	Bayou Pierre, 1852	8 16 06	14376.3	15721.5	8.93
			241 08 09	Door Point	61 11 23	11832.8	12940.0	7.35
Barrel Key	29 54 16.59	1 06 33.76	132 12 03	Sandfly	312 38 24	15971.2	17465.6	9.92
			175 16 06	Door Point	355 15 40	16588.9	18141.1	10.31
Nowhere	29 54 49.62	1 13 17.92	174 43 07	Sandfly	354 42 50	9850.2	10771.9	6.12
			275 19 46	Barrel Key	95 23 08	10888.3	11907.1	6.76
Point Comfort	29 49 31.55	1 12 44.22	174 43 36	Nowhere	354 43 19	9834.7	10754.9	6.11
			228 32 07	Barrel Key	48 35 12	13260.9	14501.7	8.24
Old Harbor Key	29 46 58.63	1 01 06.17	104 08 46	Point Comfort	284 02 59	19325.9	21134.2	12.01
			146 54 47	Barrel Key	326 52 04	16097.6	17603.9	10.00
Neptune Point, 1857	29 51 12.40	0 57 34.69	36 01 08	Old Harbor Key	215 59 22	9658.3	10562.0	6.00
			111 26 39	Barrel Key	291 22 11	15536.0	16989.7	9.65
Freemason Key	29 48 03.25	0 57 43.69	69 54 56	Old Harbor Key	249 53 15	5790.3	6332.1	3.60
			182 22 20	Neptune Point, 1857	2 22 24	5828.6	6374.0	3.62
Red Flag	29 46 41.69	0 59 33.12	101 47 43	Old Harbor Key	281 46 57	2553.3	2792.2	1.59
			229 28 30	Freemason Key	49 29 24	3865.5	4227.2	2.40
Crabtree	29 57 08.73	1 20 17.19	241 50 07	Sandfly	61 53 20	11716.7	12813.0	7.28
			290 49 23	Nowhere	110 52 52	12031.9	13157.7	7.48
Elephant Point	29 58 54.89	1 11 26.87	21 31 37	Nowhere	201 30 42	8117.6	8877.2	5.04
			219 08 26	Door Point	39 10 27	10269.9	11230.8	6.38
Live Oak Bayou	29 56 06 57	1 13 13.41	2 54 46	Nowhere	182 54 44	2372.5	2594.5	1.47
			172 08 22	Sandfly	352 07 58	7509.5	8212.2	4.67
Martin's Island	29 56 53.01	1 08 16.57	126 21 03	Elephant Point	306 19 28	6333.7	6926.3	3.93
			186 44 32	Door Point	6 44 58	11798.1	12902.0	7.33
Gallop's Green	30 00 20.73	1 10 15.87	220 43 17	Door Point	40 44 43	7021.7	7678.7	4.36
			86 10 33	Sandfly	266 09 45	5797.7	6340.2	3.60
Sunrise	30 06 47.09	1 07 28.06	208 34 15	South Point	28 35 41	9613.1	10512.6	5.97
			359 14 47	Door Point	179 14 49	6575.6	7190.9	4.08
Table Point	30 04 24.83	1 10 02.08	223 15 41	Sunrise	43 16 58	6015.6	6578.5	3.74
			297 31 10	Door Point	117 32 29	4748.9	5193.2	2.95
Grand Pass	30 05 39.78	1 11 50.06	302 21 10	Door Point	122 23 23	8409.7	9196.6	5.23
			163 28 53	Bayou Pierre, 1852	343 28 31	4190.2	4582.3	2.60
North Base	30 12 41.44	1 03 27.66	36 35 16	South Point	216 34 41	3075.0	3362.7	1.91
			106 37 25	Cat Island Light	286 34 59	8093.7	8851.0	5.03

Section VIII.—Lake Borgne. Sketch H, No. 26.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Fisher	30 11 16 19	W. 1 24 05.78	359 12 18	Grand Island, 1855	179 12 19	3996.4	4370.3	2.48
			200 09 39	Point Clear	20 10 38	9145.6	10001.4	5.68
Heron	30 10 27.53	1 26 19.98	304 24 20	Grand Island, 1855	124 25 29	4419.3	4832.8	2.75
			213 45 01	Point Clear	33 47 08	12129.3	13264.2	7.54
Gull	30 07 29.32	1 26 37.25	184 48 51	Heron	4 49 00	5506.5	6021.7	3.42
			233 57 12	Grand Island. 1855	53 58 29	5081.4	5556.9	3.16
Shell Point, screw pile	30 04 27 46	1 39 44.64	200 01 18	Rigolet Light	20 02 20	9630.9	10532.1	5.99
			269 30 08	Malheureux Point	89 35 54	18472.1	20200.5	11.48
Cedar Bayou	30 08 09.88	1 44 19.51	258 18 13	Rigolet Light	78 21 33	10877.8	11895.6	6.76
			312 55 29	Shell Point, screw pile	132 57 47	10052.1	10992.7	6.24
Bayou Besson	30 12 43.66	1 45 00.37	297 55 03	Rigolet Light	117 58 43	13292.1	14535.8	8.26
			352 36 33	Cedar Bayou	172 36 54	8500.2	9295.6	5.28
L'Herbe	30 09 24.93	1 49 49.42	284 38 39	Cedar Bayou	104 41 25	9125.5	9979.4	5.67
			231 37 17	Bayou Besson	51 39 42	9860.2	10782.8	6.13

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VIII.—Lake Borgne. Sketch H, No. 26.

Name of station.	Latitude.	Longitude.	Back azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Brick Chimney	30 12 40.17	W.1 46 17.11	266 59 50	Bayou Besson	87 00 29	2055.1	2247.4	1.28
			339 17 01	Cedar Bayou	159 18 00	8896.7	9729.2	5.53
Tall Pine	30 13 26.04	1 43 27.07	98 49 21	Bonfouca	278 45 58	10914.0	11935.2	6.78
			62 23 56	Bayou Besson	242 23 09	2815.4	3072.8	1.75
Hospital Flag-staff	30 09 59.22	1 43 33.68	277 01 41	Rigolet Light	97 04 38	9497.2	10385.8	5.90
			20 01 08	Cedar Bayou	200 00 45	3582.9	3918.2	2.23
St. Joseph's Island Light	30 11 09.26	1 24 06.57	81 22 01	Rigolet Light	261 15 12	21997.9	24056.2	13.67
			202 05 00	St. Joseph Island	22 05 02	230.5	252.1	0.14
West Rigolet Light	30 10 34.33	1 43 12.05	284 13 52	Rigolet Light	104 16 38	9127.2	9981.2	5.67
			22 05 37	Cedar Bayou	202 05 03	4799.7	5248.8	2.98
L'Orange	30 06 22.15	1 52 03.26	271 42 41	Cedar Bayou	91 46 24	12416.0	13577.8	7.71
			33 27 12	Little Woods	213 26 23	4692.3	5131.4	2.92
Wreck	30 11 40.11	1 54 30.48	352 17 41	Little Woods	172 18 06	10101.5	11046.7	6.28
			298 56 54	L'Herbe	118 59 15	8593.6	9397.7	5.34
Weem's Cotton Gin	30 11 45.02	1 42 33.50	114 19 42	Bayou Besson	294 18 26	4310.1	4713.4	2.68
			23 05 23	Cedar Bayou	203 04 30	7233.9	7910.8	4.49
Fishing Hut, chimney	30 12 51.32	1 46 31.62	275 30 55	Bayou Besson	95 31 41	2451.6	2681.0	1.52
			337 48 12	Cedar Bayou	157 49 18	9358.5	10234.2	5.81
Chef Monteur	30 06 00.77	1 47 29.41	149 12 37	L'Herbe	329 11 27	7318.1	8002.9	4.55
			231 57 32	Cedar Bayou	51 59 08	6453.1	7056.9	4.01
Additional stations in section VIII.								
Deer Island, middle	30 21 36.28	0 47 39.05	264 10 30	Marsh Point	84 11 03	3056.1	3342.1	1.90
			116 16 39	Biloxi Light	296 14 06	8987.3	9828.2	5.58
Astronomical station, public square, Mobile city.	30 41 36.97	W.0 01 10.12	....	....	....	....	....	....

Section VIII.—Vicinity of New Orleans. Sketch H, No. 26.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Labarre's Saw-mill	29 54 56.00	W.2 03 07.44	218 41 37	Marine Hospital	38 42 16	3313.5	3623.5	2.06
			104 43 55	Greenville	284 42 17	5465.9	5977.3	3.40
Rooster, flag-staff	29 57 10.42	2 03 16.22	356 44 34	Labarre's Saw-mill	176 44 38	4145.5	4533.4	2.58
			303 56 23	Marine Hospital	123 57 06	2780.7	3040.9	1.73
Charity Hospital	29 57 25.17	2 03 17.43	356 39 49	Labarre's Saw-mill	176 39 54	4600.5	5031.0	2.86
			310 37 21	Marine Hospital	130 38 05	3081.8	3370.2	1.91
Astronomical Observatory, New Orleans.	29 57 26.94	2 03 02.39	86 36 35	Charity Hospital	266 36 27	403.9	441.7	0.25
			37 49 47	Rooster, flag-staff	217 49 40	604.9	661.5	0.38
United States Mint	29 57 45.40	2 02 04.65	71 26 39	Charity Hospital	251 26 03	2057.8	2250.3	1.28
			351 42 42	Marine Hospital	171 42 49	2688.7	2940.3	1.67
Church on Jackson Street, east tower.	29 55 53.03	2 03 05.11	2 02 25	Labarre's Saw-mill	182 02 24	1757.2	1921.6	1.09
			247 32 56	Marine Hospital	67 33 33	2173.7	2377.1	1.35
Odd Fellow's Hall	29 56 57.54	2 02 46.82	8 24 29	Labarre's Saw-mill	188 24 19	3782.7	4136.6	2.35
			307 16 47	Marine Hospital	127 17 15	1908.4	2087.0	1.18
St. Patrick's Church, southeast turret.	29 56 52.95	2 02 48.62	7 58 34	Labarre's Saw-mill	187 58 25	3636.1	3976.3	2.26
			302 55 41	Marine Hospital	122 56 10	1866.9	2041.6	1.16
Lafayette Square Church Spire	29 56 56.85	2 02 51.21	67 50 16	Greenville	247 48 30	6178.1	6756.2	3.84
			304 44 30	Marine Hospital	124 45 00	1991.0	2177.3	1.24

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section IX.—Lavaca bay, Carankaway bay, and Espiritu Santo bay. Sketch H, No. 28.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Sand Point	28 35 04.85	W.8 26 09.40	242 36 32	Well Point	62 40 11	13993.7	15303.1	8.69
			8 43 24	La Salle	188 42 59	9431.6	10314.1	5.86
Indianola	28 32 27.26	8 30 09.36	233 27 48	Sand Point	53 29 42	8115.3	8874.7	5.04
			311 23 56	La Salle	131 25 25	6792.5	7428.1	4.22
Gallinipper	28 35 02.54	8 33 13.63	269 37 07	Sand Point	89 40 30	11527.0	12605.6	7.16
			313 31 42	Indianola	133 33 10	6907.7	7554.0	4.29
Sheldon's House	28 38 45.51	8 32 49.49	5 27 38	Gallinipper	185 27 26	6894.9	7540.0	4.28
			339 28 07	Indianola	159 29 24	12409.8	13571.0	7.71
Lavaca	28 37 36.22	8 36 28.64	250 16 03	Sheldon's House	70 17 48	6322.2	6913.8	3.93
			311 45 11	Gallinipper	131 46 44	7102.1	7766.6	4.41
Noble's House	28 36 41.68	8 36 04.06	325 31 37	Gallinipper	145 32 58	8181.6	8947.2	5.08
			18 19 03	Lavaca	198 18 51	2122.7	2321.3	1.32
Garcitas	28 42 51.09	8 37 18.22	335 15 34	Gallinipper	155 17 31	15879.0	17364.8	9.86
			316 00 11	Sheldon's House	136 02 20	10505.5	11488.5	6.53
House	28 36 06.94	8 35 58.19	163 15 15	Lavaca	343 15 00	2870.0	3138.5	1.78
			293 54 07	Gallinipper	113 55 26	4890.5	5348.1	3.04
Brant's Barn	28 35 15.27	8 27 52.10	276 33 11	Sand Point	96 34 00	2808.9	3071.7	1.75
			35 55 35	Indianola	215 54 29	6359.6	6954.7	3.95
Treikeld House	28 37 16.88	8 25 47.70	258 39 47	Well Point	78 43 16	12071.2	13200.7	7.50
			8 15 08	Sand Point	188 14 56	4107.0	4491.3	2.55
Carankaway	28 39 50.75	8 23 44.18	285 35 25	Well Point	105 37 55	8805.2	9629.1	5.47
			24 08 59	Sand Point	204 07 50	9644.3	10546.7	5.99
Dunbar House	28 26 23.70	8 18 18.50	115 17 52	La Salle	295 13 42	15745.3	17218.6	9.78
			221 03 21	Osgood	41 03 56	3231.8	3534.2	2.01
Pass Cavallo Light	28 20 49.21	8 23 05.37	159 17 16	La Salle	339 15 23	18193.6	19896.0	11.30
			217 55 46	Osgood	37 58 30	16148.2	17659.2	10.03
Espiritu Santo	28 22 58.87	8 30 16.17	202 03 53	La Salle	22 05 26	14055.2	15370.3	8.73
			288 45 52	Pass Cavallo Light	108 49 17	12390.0	13549.3	7.70
Rahal	28 16 41.23	8 31 41.50	191 18 00	Espiritu Santo	11 18 40	11854.6	12963.8	7.36
			241 28 04	Pass Cavallo Light	61 32 00	15998.1	17495.0	9.94
Steamboat Pass	28 18 48.85	8 36 14.21	231 41 24	Espiritu Santo	51 44 14	12421.4	13583.7	7.72
			297 50 56	Rahal	117 53 05	8404.5	9190.9	5.22
Mott	28 22 51.54	8 34 22.50	268 03 42	Espiritu Santo	88 05 40	6738.6	7368.9	4.18
			338 49 45	Rahal	158 51 02	12222.8	13366.5	7.59
Cant Island	28 21 41.25	8 33 07.12	275 32 30	Pass Cavallo Light	95 37 25	16463.5	18004.0	10.23
			242 48 47	Espiritu Santo	62 50 06	5231.6	5721.1	3.25
Rahal's House	28 18 16.63	8 29 03.80	167 13 24	Espiritu Santo	347 12 50	8908.6	9742.2	5.54
			244 17 09	Pass Cavallo Light	64 19 59	10833.5	11847.2	6.73
Wilkinson's House	28 20 04.70	8 25 43.94	125 53 48	Espiritu Santo	305 51 30	9148.2	10004.2	5.68
			252 23 16	Pass Cavallo Light	72 24 31	4530.6	4954.5	2.81
Saluria Light	28 24 06.95	8 23 25.56	354 50 17	Pass Cavallo Light	174 50 27	6111.6	6683.7	3.80
			79 24 28	Espiritu Santo	259 21 13	11371.6	12435.6	7.06
Saluria	28 23 55.50	8 23 09.66	236 06 44	Osgood	55 20 40	12243.2	13388.8	7.61
			150 45 11	La Salle	330 43 20	12931.6	14141.6	8.04
Decrose House	28 24 20.17	8 21 28.09	139 13 03	La Salle	319 10 24	13900.7	15201.4	8.64
			229 23 34	Osgood	49 25 41	9589.3	10486.6	5.96
Alligator, Mott	28 28 06.24	8 25 02.30	273 22 43	Osgood	93 26 33	13129.8	14358.3	8.16
			137 05 44	La Salle	317 04 47	4781.3	5228.7	2.97
Alligator Signal	28 27 13.02	8 23 23.03	162 42 47	Sand Point	342 41 26	15212.1	16635.5	9.45
			131 08 51	La Salle	311 07 07	7907.4	8647.3	4.91
Wolf Point	28 42 20.58	8 23 40.26	1 05 11	Carankaway	181 05 00	4612.9	5044.5	2.87
			309 44 25	Well Point	129 46 53	10915.9	11937.3	6.78

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section X.—Napa creek. Sketch I, No. 31.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles*
Vallejo Hill	38 06 58.44	122 14 53.31	4 47 00	Mare Island, northwest.	184 46 54	3065.8	3352.7	1.90
			332 28 58	Vallejo, (1)	152 29 40	3577.4	3912.1	2.22
Slaughter-house Point	38 09 14.96	122 16 05.91	337 12 31	Vallejo Hill	157 13 16	4564.9	4992.0	2.84
			348 13 56	Mare Island, northwest.	168 14 34	7419.8	8114.1	4.61
Napa Branch	38 11 09.00	122 18 33.07	0 42 31	Long Pond	180 42 29	6500.9	7109.2	4.04
			314 27 20	Slaughter-house Point	134 28 51	5019.0	5488.6	3.12
Navy Yard Slough	38 09 24.31	122 18 12.22	275 20 57	Slaughter house Point	95 22 15	3088.5	3377.5	1.92
			171 03 57	Napa Branch	351 03 44	3266.9	3572.6	2.03
Green Hill	38 12 04.26	122 16 20.45	356 07 14	Slaughter-house Point	176 07 23	5231.8	5721.3	3.25
			62 10 31	Napa Branch	242 09 09	3649.1	3990.5	2.27
Good Luck Point	38 10 59.48	122 17 11.57	98 24 57	Napa Branch	278 24 07	2004.8	2192.4	1.24
			211 54 44	Green Hill	31 55 16	2353.0	2573.2	1.46
Fly's Hill	38 13 09.61	122 19 03.72	348 39 34	Napa Branch	168 39 53	3792.5	4147.4	2.36
			296 52 57	Green Hill	116 54 38	4453.3	4870.0	2.77
Suscol Hill	38 14 33.85	122 15 32.70	63 10 26	Fly's Hill	243 08 16	5751.5	6289.7	3.57
			14 08 21	Green Hill	194 07 51	4755.8	5200.8	2.95
Home Hill	38 14 23.60	122 16 47.50	351 17 21	Green Hill	171 17 38	4345.9	4752.5	2.70
			55 27 29	Fly's Hill	235 26 05	4022.0	4398.3	2.50
Green Island	38 12 45.95	122 17 28.55	27 42 32	Napa Branch	207 41 52	3376.1	3692.0	2.10
			307 47 34	Green Hill	127 48 16	2096.7	2292.9	1.30
Fly's House, chimney	38 13 46.26	122 18 01.46	321 59 21	Green Hill	142 00 23	3990.4	4363.8	2.48
			247 54 24	Suscol Hill	67 55 56	3903.7	4269.0	2.43
Stony Hill	38 15 57.71	122 17 09.33	28 13 49	Fly's Hill	208 12 38	5881.6	6431.9	3.65
			349 37 55	Home Hill	169 38 09	2949.6	3225.6	1.83
Ferry House Chimney	38 14 35.08	122 16 03.33	59 01 21	Fly's Hill	238 59 29	5117.3	5596.1	3.18
			157 48 10	Stony Hill	337 47 29	3010.8	3292.5	1.87
Napa Hill	38 18 03.85	122 14 54.77	40 04 25	Stony Hill	220 03 02	5080.2	5555.6	3.16
			8 06 28	Suscol Hill	188 06 04	6540.2	7152.2	4.06
Napa Creek	38 15 36.57	122 16 09.86	22 08 19	Home Hill	202 07 56	2428.6	2655.8	1.51
			114 16 35	Stony Hill	294 15 58	1586.0	1734.4	0.98
Court-house Spire	38 17 50.08	122 16 07.16	256 25 21	Napa Hill	76 26 06	1809.2	1978.5	1.12
			8 45 39	Home Hill	188 45 14	6441.3	7044.0	4.00
Green's House, chimney	38 17 24.72	122 17 42.74	343 09 40	Stony Hill	163 10 01	2802.6	3064.8	1.74
			329 01 29	Suscol Hill	149 02 50	5143.8	6718.7	3.82

Section X.—Petaluma creek. Sketch I, No. 32.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Point Penole	38 00 40.68	122 20 59.60	....	....	....	....	....	....
Petaluma Creek	38 06 10.55	122 28 23.88	313 09 40	Point Penole	133 14 14	14856.2	16246.3	9.23
Tolay Creek	38 07 57.17	122 23 50.68	342 46 14	Point Penole	162 47 59	14087.9	15406.1	8.75
			63 44 02	Petaluma Creek	243 41 13	7421.7	8116.1	4.61
Swift	38 08 29.34	122 27 52.34	10 10 50	Petaluma Creek	190 10 31	4347.2	4754.0	2.70
			279 32 41	Tolay Creek	99 35 10	5967.3	6525.6	3.71
Novata	38 08 19.44	122 31 23.22	266 34 51	Swift	86 37 01	5143.7	5625.0	3.20
			312 16 45	Petaluma Creek	132 18 36	5904.8	6457.3	3.67
Sears	38 10 16 90	122 30 27.25	20 37 28	Novata	200 36 53	3869.1	4231.1	2.40
			311 18 51	Swift	131 20 27	50.1.6	5491.5	3.12
San Antonio	38 09 52.90	122 33 07.90	259 16 25	Sears	79 18 04	3979.7	4352.1	2.47
			318 29 57	Novata	138 31 02	3846.8	4206.7	2.39
Lakeville	38 12 11.75	122 31 58.10	21 38 58	San Antonia	201 38 15	4605.5	5036.4	2.86
			328 00 55	Sears	148 01 51	4174.5	4565.1	2.59
Haydon	38 12 23.15	122 34 37.84	275 09 15	Lakeville	95 10 54	3901.8	4266.9	2.42
			334 42 19	San Antonia	154 43 15	5123.1	5602.5	3.18
Bodwell	38 13 52.32	122 33 25.98	32 27 08	Haydon	212 26 24	3257.7	3562.5	2.02
			325 24 42	Lakeville	145 25 36	3766.0	4118.4	2.34

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section X.—Petaluma creek. Sketch No. 32.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres*	*Yards.*	*Miles.*
Italian	38 13 33.95	122 35 50.58	260 50 07	Bodwell	80 51 36	3561.9	3895.2	2.21
			320 57 50	Haydon	140 58 35	2809.7	3072.6	1.75
Flat	38 14 52.85	122 35 23.58	15 06 16	Italian	195 05 59	2519.6	2755.4	1.56
			346 26 33	Haydon	166 27 01	4747.4	5191.6	2.95
Petaluma, Baptist Church spire	38 14 10.14	122 37 33.80	247 24 25	Flat	67 25 46	3429.0	3749.8	2.13
			293 57 30	Italian	113 58 34	2746.9	3003.9	1.71

Section X.—Tomales Bay. Sketch J, No. 31.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Table Mountain	37 55 24.48	122 34 46.68	....	....	....	....	....	....
Rocky Mound	37 52 54.26	122 13 31.82	98 34 04	Table Mountain	278 21 00	31483.9	34429.8	19.56
Sonoma Mountain	38 19 21.69	122 33 29.36	2 26 25	Table Mountain	182 25 37	44348.4	48498.1	27.55
			329 05 51	Rocky Mound	149 18 10	56975.4	62306.6	35.40
Tomales Bay	38 10 52.52	122 55 48.38	312 49 17	Table Mountain	133 02 14	42006 9	45937.5	26.10
			244 08 27	Sonoma Mountain	64 22 16	36140.4	39522.0	22.45
Ross Mountain	38 30 17.68	123 06 10.99	292 51 29	Sonoma Mountain	113 11 48	51703.5	56541.4	32.13
			337 07 24	Tomales Bay	157 13 50	38974.2	42621.0	24.22
Sulphur Peak	38 45 51.41	122 49 41.87	334 15 16	Sonoma Mountain	154 25 22	54377.4	59465.5	33.79
			7 50 53	Tomales Bay	187 47 05	65318.7	71430.5	40.58
Punta Reyes	38 04 45.36	122 51 02.40	223 23 16	Sonoma Mountain	43 34 07	37232.1	40715.9	23.13
			148 25 24	Tomales Bay	328 22 27	13290.2	14533.8	8.26
Bodega	38 18 20.78	122 59 05.42	266 59 12	Sonoma Mountain	87 15 05	37358.8	40854.4	23.21
			340 51 48	Tomales Bay	160 53 50	14626.8	15995.4	9 09
Smith	38 14 48.60	122 55 10.52	138 54 31	Bodega	318 52 05	8682.5	9494.9	5.39
			7 12 55	Tomales Bay	187 12 32	7336.3	8022.8	4 56
Tomales Point	38 12 42.81	122 57 16.11	218 12 41	Smith	38 13 59	4936.8	5398.7	3.07
			327 52 24	Tomales Bay	117 53 18	4014.5	4390.1	2.49
Bodega Head	38 18 26.34	123 02 47.11	301 07 59	Smith	121 12 42	12969.1	14182.6	8.06
			322 44 54	Tomales Point	142 48 19	13301.0	14545 6	8.26
Preston	38 12 12.05	122 54 22.16	40 33 29	Tomales Bay	220 32 36	3226.9	3528.8	2.00
			102 38 43	Tomales Point	282 36 55	4336.5	4742.3	2.69
Mershon	38 10 52.36	122 53 07.64	90 05 08	Tomales Bay	270 03 29	3911.6	4277.6	2.43
			143 34 45	Preston	323 33 59	3053.4	3339.1	1.90
Foster	38 08 10.46	122 53 24.90	184 48 30	Mershon	4 48 41	5009.2	5477.9	3.12
			145 03 25	Tomales Bay	325 01 56	6096.1	6666.5	3.79
Reynolds	38 08 56.11	122 52 14.48	50 37 41	Foster	230 36 57	2218.2	2425.8	1.38
			160 09 10	Mershon	340 08 37	3810.7	4167.3	2.37
Hans	38 07 55.54	122 51 03.67	97 37 51	Foster	277 36 24	3469.5	3794.1	2.16
			137 17 33	Reynolds	317 16 49	2541.4	2779.2	1.58
Mike	38 07 27.65	122 51 55.75	170 30 42	Reynolds	350 30 30	2765.0	3023.7	1.72
			235 51 23	Hans	55 51 55	1532.3	1675.7	0.95
Frink	38 06 57.97	122 50 02.81	140 08 13	Hans	320 07 35	2312.3	2528.7	1.43
			108 24 20	Mike	288 23 10	2898.9	3170.1	1.80
Agnew	38 06 38.04	122 50 55.31	244 19 47	Frink	64 20 19	1418.7	1551.4	0.88
			175 07 37	Hans	355 07 32	2397.9	2622.3	1.49
Young	38 06 01.44	122 50 15.73	139 29 33	Agnew	319 29 09	1484.2	1623.1	0.92
			190 14 04	Frink	10 14 12	1771.1	1936.8	1.10
Sigvart	38 06 05.02	122 49 05.33	139 23 08	Frink	319 22 33	2150.7	2351.9	1.34
			86 19 23	Young	266 18 40	1718.7	1879.5	1 07
Willow Point	38 05 24.14	122 49 30.77	136 23 59	Young	316 23 31	1588.3	1736.9	0.99
			206 11 02	Sigvart	26 11 18	1404.7	1536.1	0.87
Hammond	38 04 42 07	122 47 36.58	114 59 52	Willow Point	294 58 42	3069.9	3357.1	1.91
			139 47 24	Sigvart	319 46 29	3349.1	3662.5	2.08
Creek	38 04 22.64	122 48 33.14	143 28 44	Willow Point	323 28 08	2359.4	2580.2	1.46
			246 30 15	Hammond	66 30 50	1503.0	1643.6	0.93

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section X.—Tomales Bay. Sketch J, No. 31.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Grasier	38 03 43.00	122 47 41.94	134 23 54	Creek	314 23 22	1746.5	1909.9	1.08
			184 06 14	Hammond	4 06 17	1825.7	1996.5	1.13
Tom's Point	38 13 07.55	122 56 09.81	352 51 36	Tomales Bay	172 51 49	4195 6	4588.2	2.61
			64 41 29	Tomales Point	244 40 48	1784.1	1951.0	1.11
Hog Island	38 11 48.98	122 55 06.67	236 41 30	Preston	56 41 57	1295.6	1416.8	0.80
			301 03 55	Mershon	121 05 09	3381.4	3697.8	2.14
Preston's House, stove-pipe	38 12 43.32	122 54 57.75	19 50 08	Tomales Bay	199 49 37	3631.4	3971.2	2.26
			89 44 24	Tomales Point	269 42 58	3365.7	3650.6	2.09
Lone House, south gable	38 12 25.18	122 54 28.87	34 06 52	Tomales Bay	214 06 03	3449.9	3772.7	2.14
			97 37 30	Tomales Point	277 35 47	4104.4	4488.4	2.55
Blake's House, southeast gable	38 11 36.27	122 54 04.21	61 59 23	Tomales Bay	241 58 19	2871.3	3140.0	1.78
			113 44 11	Tomales Point	293 42 12	5099.2	5576.3	3.17
Punta Reyes Beach	38 07 27.63	122 56 16.63	186 12 44	Tomales Bay	6 13 01	6354.1	6948.6	3.95
			252 27 48	Foster	72 29 34	4385.6	4796.0	2.72
Magnetic Station	38 11 10.99	122 55 39.94	278 47 38	Mershon	98 49 12	3750.4	4101.3	2.33
			19 49 43	Tomales Bay	199 49 38	605.2	661.8	0.38
Sugar-loaf Hill	38 14 27.10	122 56 32.84	350 42 46	Tomales Bay	170 43 13	6703.4	7330.6	4 16
			18 07 46	Tomales Point	198 07 19	3383.0	3699.5	2.10
Teton	38 15 10.69	122 56 35.03	12 21 45	Tomales Point	192 21 20	4668.0	5104.8	2.90
			288 19 15	Smith	108 20 07	2164.7	2367.2	1.34
Richard's	38 04 00.09	122 57 00.53	187 51 43	Tomales Bay	7 52 27	12835.9	14037.0	7.98
			214 13 10	Foster	34 15 23	9336.7	10210.3	5.80

Section XI.—Gulf of Georgia. Sketch K, No. 34.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Matia, north	48 44 41.24	W.0 07 57.12	240 41 11	South Base	60 46 14	9426.0	10308.0	5.86
			267 15 21	Lummi, north	87 20 08	7814.5	8545.7	4.85
Point Whitehorn, (1)	48 53 07.29	0 05 51.09	161 07 47	Lummi, north	161 07 47	16131.3	17640.7	10.02
			332 51 58	South Base	152 55 26	12381.6	13540.2	7.69
Trident	48 47 08.79	0 15 11.13	284 01 28	Lummi, north	104 11 42	17182.7	18790.5	10.68
			269 44 25	South Base	89 54 55	17077 4	18675.3	10.61
East Roberts	48 58 24.09	0 20 15.69	298 59 16	Point Whitehorn, (1)	119 10 06	20123.8	22017.7	12.51
			343 24 09	Trident	163 27 59	21761.4	23797.6	13.52
Disappointment	48 51 20.10	0 33 25.73	230 45 48	East Roberts	50 55 43	20740.8	22681.5	12.89
			289 03 27	Trident	109 17 11	23636.2	25847.8	14 69
West Roberts	48 58 15.12	0 23 39.63	293 30 12	Point Whitehorn, (1)	113 43 38	23734.5	25955.3	14 75
			43 00 31	Disappointment	222 53 09	17513.0	19151.7	10.88
Birch Point	48 56 27.85	0 07 58.90	103 32 58	East Roberts	283 23 42	15411.7	16853.8	9.58
			99 55 22	West Roberts	279 43 32	19420.0	21237.1	12.07
Point Whitehorn, (2)	48 53 37.89	0 06 16.04	42 17 14	Trident	222 10 31	16231.3	17750.1	10.08
			117 26 34	East Roberts	297 16 01	19438.3	21257.1	12.08
Mount Constitution	48 40 37.23	0 08 31.36	227 04 15	Lummi, north	47 09 28	11615.9	12702.8	7.22
			216 16 20	South Base	36 21 48	15073.5	16483.9	9 37
Barton	48 55 52.58	0 06 12.25	34 13 34	Trident	214 06 48	19554.2	21383.9	12.15
			1 03 56	Point Whitehorn, (2)	181 03 53	4160.7	4550.0	2.58
Trail	48 54 17.46	0 04 44.29	56 49 30	Point Whitehorn, (2)	236 48 21	2232.6	2441.5	1.39
			148 39 02	Barton	328 37 56	3440.6	3762.5	2.14
Satellite	49 01 26.72	0 10 04.49	344 31 38	Birch Point	164 33 13	9577.9	10474.1	5.95
			65 38 25	East Roberts	245 30 43	13642.8	14919.4	8.48
Sea Bird	48 57 18.80	0 07 43.19	97 35 09	East Roberts	277 25 42	15436 4	16880.8	9.59
			159 27 21	Satellite	339 25 34	8178.7	8944.0	5.08
Semi-ah-moo	49 00 47.52	0 05 35.08	22 00 37	Sea Bird	201 59 00	6953.2	7603.6	4.32
			102 30 11	Satellite	282 26 48	5605.4	6129.9	3.48
Drayton, (1)	48 58 45.52	W.0 06 00.89	135 11 29	Satellite	315 08 25	7021.3	7678.3	4.36
			187 55 20	Semi-ah-moo	7 55 40	3804.6	4160.6	2.36

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section XI.—Gulf of Georgia. Sketch K, No. 34.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	Metres.	Yards.	Miles.
Prairie	48 56 19.06	W.0 05 08.41	352 32 55	Trail	172 33 13	3787.8	4142.2	2.35
			15 28 01	Point Whitehorn, (2)	195 27 10	5164.7	5648.0	3.21
East Point, (2)	48 47 03.36	0 21 19.28	183 31 07	East Roberts	3 31 55	21065.9	23037.0	13.09
			290 08 28	Sucia, west	110 11 58	9530.5	10422.3	5.92
Matia, northwest	48 44 57.16	0 09 18.24	270 41 55	Lummi, north	90 47 43	9463.2	10348.7	5.88
			247 19 25	South Base	67 25 29	10702.1	11703.5	6.65
Launch	48 45 01.81	0 11 28.45	252 21 02	South Base	72 28 44	13151.4	14382.0	8.17
			271 11 55	Lummi, north	91 19 21	12124.8	13259.3	7.53
Sucia, northeast	48 45 44.84	0 11 15.78	257 46 58	South Base	77 54 30	12558.0	13733.1	7.80
			295 49 05	Matia, north	115 51 34	4507.9	4929.7	2.80
Gyp	48 50 21.63	0 01 28.88	0 42 00	Lummi, north	180 42 04	10145.8	11095.1	6.30
			70 32 10	Trident	250 21 51	17790.6	19465.1	11.06
Northwest Bell's Chain, Point Roberts.	48 58 30.72	0 20 08.51	299 42 01	Point Whitehorn, (1)	119 52 47	20106.4	21987.8	12.49
			312 10 01	South Base	132 24 16	31229.2	34151.3	19.40
Marked Tree, (1)	48 49 08.77	0 01 12.81	45 13 10	Matia, north	225 08 08	11635.1	12723.8	7.23
			78 03 44	Trident	257 53 13	17488.4	19124.8	10.87
Marked Tree, (3)	48 52 24.03	0 04 32.87	16 16 16	Matia, north	196 13 42	14889.6	16282.8	9.25
			53 16 07	Trident	233 08 07	16254.4	17775.3	10.10
Marked Tree, (8)	48 45 49.83	0 11 22.51	258 35 37	South Base	78 43 14	12661.0	13845.7	7.87
			296 46 34	Matia, north	116 49 06	4690.3	5130.0	2.92
Marked Tree, (10)	48 46 07.97	0 13 32.30	132 57 53	Trident	312 56 30	2756.7	3014.6	1.71
			215 56 21	Point Whitehorn, (1)	36 02 06	16006.4	17504.1	9.94
Marked Tree, (9)	48 45 55.34	0 11 47.66	278 39 38	Lummi, north.	98 47 19	12658.8	13843.3	7.87
			259 45 29	South Base	79 53 25	13133.8	14362.7	8.16
Marked Tree, (13)	48 58 30.16	0 19 59.46	299 55 18	Point Whitehorn, (1)	190 05 58	19938.6	21804.3	12.39
			344 22 33	Trident	164 26 10	21849.9	23894.4	13.58
Marked Tree, (15)	48 47 50.66	0 23 12.79	117 25 36	Disappointment	297 17 55	14075.0	15392.0	8.74
			190 25 41	East Roberts	10 27 54	19894.9	21756.5	12.36
Marked Tree, (16)	48 47 53.79	0 23 47.02	118 25 38	Disappointment	298 18 22	13412.4	14667.4	8.33
			192 26 44	East Roberts	12 29 24	19938.5	21804.2	12.39
Marked Tree, (17)	48 47 59.83	0 24 22.08	119 12 58	Disappointment	299 06 09	12695.6	13883.6	7.89
			194 33 49	East Roberts	14 36 55	19924.2	21788.5	12.38
Marked Tree, (21)	49 00 11.33	0 24 08.35	350 45 31	West Roberts	170 45 53	3636.6	3976.9	2.26
			34 42 55	Disappointment	214 35 55	19948.0	21814.5	12.39
Cherry Point	48 51 37.27	0 03 28.68	341 36 31	South Base	161 38 12	8684.4	9497.0	5.40
			349 27 23	Lummi, north	169 28 49	12694.9	13882.7	7.89
Northwest Bell's Chain, Point Whitehorn.	48 53 31.72	0 03 14.08	7 19 11	Matia, north	187 17 53	16519.2	18064.9	10.26
			42 50 57	Trident	222 44 13	16117.9	17626.0	10.01
Bell's Chain	48 49 22.24	0 29 34.20	283 05 01	Trident	103 15 50	18084.7	19776.9	11.24
			127 39 49	Disappointment	307 36 55	5961.4	6519.2	3.70
Bell's chain, hydrographic signal.	48 49 22.98	0 29 35.74	127 40 25	Disappointment	307 37 32	5922.4	6476.6	3.68
			214 15 02	East Roberts	34 22 04	20234.1	22127.4	12.57
Grasshopper	48 49 58.52	0 30 42.30	219 11 08	East Roberts	31 19 00	20165.5	22052.4	12.53
			285 19 51	Trident	105 31 32	19706.2	21550.1	12.24
East Point, (3)	48 46 51.12	0 21 30.08	287 32 23	Sucia, west	107 38 01	9617.5	10517.4	5.98
			266 13 51	Patos Island	86 17 18	5639.9	6167.6	3.50
Blue Bell	48 59 04.48	0 20 10.10	287 56 41	Birch Point	108 05 52	15638.5	17101.8	9.72
			282 03 04	Sea Bird	102 12 28	15535.3	16989.0	9.65
Marked Tree, (B)	48 53 59.15	0 05 08.32	159 37 45	Barton	339 36 57	3737.4	4087.1	2.32
			179 58 26	Prairie	359 58 26	4321.4	4725.8	2.68
Marked Tree, (A)	48 53 39.83	0 05 38.43	151 09 33	Birch Point	331 07 47	5925.3	6479.7	3.68
			187 04 49	Prairie	7 05 12	4955.8	5419.5	3.08
Marked Tree, (C)	48 54 26.32	0 04 11.35	137 16 59	Barton	317 15 28	3630.4	3970.1	2.26
			161 33 27	Prairie	341 32 44	3670.6	4014.1	2.28
Marked Tree, (D)	48 54 44.34	0 03 35.99	123 32 01	Barton	303 30 03	3816.0	4173.1	2.37
			147 17 29	Prairie	327 16 19	3478.1	3803.5	2.16
Encampment	48 55 33.06	0 03 22.17	44 52 45	Point Whitehorn, (2)	224 50 35	5018.4	5488.0	3.12
			35 36 25	Trail	215 35 23	2871.9	3140.6	1.79
Bluff	48 59 44.44	0 20 43.82	291 14 38	Birch Point	111 24 15	16698.4	18260.9	10.37
			285 44 29	Sea Bird	105 54 18	16497.7	18041.4	10.25
aHead Reef	48 45 33.20	W.0 25 13.30	254 42 43	Patos Island	74 48 58	10557.8	11545.7	6.56
			295 36 17	Bare Island	115 40 35	7780.5	8508.5	4.83

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section XI.—Gulf of Georgia. Sketch K, No. 34.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Tumbow, east	48 47 34.77	W.0 21 44.29	185 07 58	East Roberts	5 09 06	20136.7	22020.9	12.51
			279 22 41	Patos Island	99 26 19	5996.1	6559.3	3.73
Tumbow, northeast	48 47 48.47	0 22 20.60	281 52 06	Patos Island	101 56 13	6804.4	7441.1	4.23
			294 35 07	Sucia, west	114 41 23	11219.0	12268.6	6 97
Whitewashed Rocks, Active harbor.	48 45 30.42	0 13 50.48	17 19 03	Sucia, west	197 18 55	724 0	791.7	0.45
			62 51 09	Bare Island	242 47 46	7793.9	8523.2	4.84
Whitewashed Tree, east point	48 47 06.03	0 21 21.22	290 29 17	Sucia, west	110 34 48	9596.3	10494.2	5.96
			334 17 51	East Point, (2)	154 17 52	91.4	100.0	0.06
High Bluff, east point	48 46 56.61	0 21 22.56	288 47 18	Sucia, west	108 52 50	9524.3	10415.5	5.92
			338 49 49	Bare Island	158 51 14	6373.2	6969.5	3.96
East Point, Plumper signal	48 47 06.55	0 21 20.74	271 07 03	Patos Island	91 10 23	5438.2	5947.1	3.38
			340 04 57	Bare Island	160 06 20	6647.1	7269.1	4.13
Semi-ah-moo Flag-staff	49 00 49.10	0 05 40.66	102 15 32	Satellite	282 12 13	5484 3	5997.5	3.41
			75 57 27	East Roberts	255 46 27	18340.8	20056.9	11.40
Shaw's Bluff	48 59 15.00	0 03 44.40	71 51 10	Drayton, (1)	251 49 27	2920.5	3193.8	1.81
			141 48 22	Semi-ah-moo	321 46 58	3637.1	3977.4	2.26
Brant	48 57 32.43	0 03 11.04	123 11 26	Drayton, (1)	303 09 18	4126.5	4512.6	2.56
			167 55 17	Shaw's Bluff	347 54 52	3239.9	3543.0	2.01
Camp	49 00 47.69	0 05 36.25	102 29 55	Satellite	282 26 33	5581.2	6103.4	3.47
			76 09 31	East Roberts	255 52 27	18417.0	20140.3	11.44
Semi-ah-moo Observatory	49 00 47.95	0 05 35.91	21 50 26	Sea Bird	201 48 50	6959.2	7610.4	4.32
			102 24 26	Satellite	282 21 04	5586.1	6108.8	3.47
Parallel	49 00 04.38	0 04 06.09	109 17 30	Satellite	289 13 00	7713.2	8434.9	4.79
			126 24 07	Semi-ah-moo	306 23 00	2246.3	2456.5	1.40
Drayton, (2)	48 59 23.67	0 04 57.75	163 40 33	Semi-ah-moo	343 40 05	2699.0	2951.5	1.68
			280 10 38	Shaw's Bluff	100 11 33	1514.9	1656.6	0.94
Cross, hydrographic signal	48 58 41.25	0 06 10.54	137 05 44	Satellite	317 02 47	6980.5	7633.7	4.34
			190 27 54	Semi-ah-moo	10 28 21	3966.3	4337.4	2.46
Tumbow, west	48 47 48.83	0 24 40.24	195 22 07	East Roberts	15 25 27	20351.7	22266.0	12.65
			183 41 12	West Roberts	3 41 58	19385.2	21199.1	12.04
Whitewashed Western Rocks of Bell's chain.	48 50 13.36	0 31 06.23	126 20 53	Disappointment	306 19 09	3479.6	3805.2	2.16
			221 10 07	East Roberts	41 18 19	20156.5	22042.5	12.52
Filigree	48 52 22.79	0 35 45.47	239 22 34	East Roberts	59 34 15	21970.3	24026.0	13.65
			233 32 54	West Roberts	53 42 01	18349.8	20066.8	11.40
Pender	48 53 37.06	0 38 00.79	247 38 31	East Roberts	67 51 54	23417.9	25609.1	14.55
			307 01 05	Diappointment	127 04 32	7021.3	7678.3	4.36
Whitewashed Western Rocks, Plumper signal.	48 53 58.33	0 38 42.86	249 51 57	East Roberts	70 05 52	23978.7	26222.4	14.90
			246 33 45	West Roberts	66 45 06	20018.5	21891.6	12.44
Frazer's River	49 01 28.71	0 26 23.35	330 53 14	West Roberts	150 55 18	6842.8	7483.1	4.25
			24 36 47	Disappointment	204 31 29	20669.9	22604.0	12.84
East Point Reef	48 47 16.35	0 21 06.90	343 10 18	Bare Island	163 11 31	6845.4	7485.9	4.25
			32 12 03	East Point, (2)	212 11 54	473.9	518.2	0.30
Marked Tree 2, Drayton Head	48 57 26.11	0 03 27.14	128 07 36	Drayton, (1)	308 05 53	3974.1	4346.0	2.47
			174 02 43	Shaw's Bluff	354 02 30	3381.5	3697.9	2.10
Marked Tree 3, Drayton Head	48 57 36.47	0 04 04.24	132 08 35	Drayton, (1)	312 07 06	3179.4	3476.9	1.98
			187 48 54	Shaw's Bluff	7 49 10	3071.7	3359.1	1.91
Marked Tree 4, Drayton Head	48 57 37.87	0 04 15.82	134 22 27	Drayton, (1)	314 21 06	2988.6	3268.2	1.86
			192 01 16	Shaw's Bluff	12 01 40	3067.3	3354.3	1.91
Marked Tree 5, Drayton Head	48 57 54.34	0 05 04.58	144 05 26	Drayton, (1)	324 04 43	1952.1	2134.8	1.21
			213 11 34	Shaw's Bluff	33 12 35	2977.3	3255.9	1.85
Marked Tree 6, Drayton Head	42 58 08.56	0 05 39.59	159 13 44	Drayton, (1)	339 13 28	1221.1	1335.4	0.76
			228 45 58	Shaw's Bluff	48 47 25	3113.9	3405.3	1.93
Shell Bank	48 57 47.65	0 04 39.39	137 10 26	Drayton, (1)	317 09 24	2437.6	2665.7	1.52
			202 30 33	Shaw's Bluff	22 31 14	2920.4	3193.7	1.81
Northwest Patos	48 47 18.66	W.0 16 56.71	278 03 06	Trident	98 04 16	2176.3	2379.9	1.35
			231 30 00	Point Whitehorn, (1)	51 38 21	17321.5	18945.5	10.76

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section XI.—Admiralty Inlet. Sketch K, No. 34.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	Metres.	Yards.	Miles.
Astronomical Station, 1852, Point Hudson.	48 07 03.02	....	....	....	....	....	....	....
Point Hudson, astronomical azimuth station, 1856.	48 07 06.71	E. 0 00 07.18	52 29 00	Astronomical Station, 1852	232 29 15	187.2	204.7	0.12
Admiralty Head	48 09 21.56	0 04 24.97	52 01 11	Point Hudson	231 57 59	6763.2	7396.0	4.20
Kilisut	48 05 57.30	E. 0 02 04.63	131 26 18	Point Hudson	311 24 51	3239.8	3542.9	2.01
			204 41 13	Admiralty Head	24 42 58	6943.5	7593.2	4.31
Southwest Base	48 05 35.42	W. 0 03 01.31	263 52 33	Kilisut	83 56 20	6365.2	6960.8	3.95
			234 06 34	Point Hudson	54 08 55	4811.3	5261.5	2.99
Walan	48 04 34.23	E. 0 00 22.90	114 07 01	Southwest Base	294 04 29	4629.0	5062.1	2.88
			176 03 06	Point Hudson	356 02 54	4720.3	5162.0	2.93
Northeast Base	48 06 37.57	W. 0 01 18.19	286 29 29	Kilisut	106 32 00	4375.8	4785.2	2.72
			331 13 06	Walan	151 14 22	4345.6	4752.2	2.70
Point Wilson	48 08 42.74	W. 0 00 16.39	258 19 19	Admiralty Head	78 22 49	5936.9	6492.4	3.69
			330 16 18	Kilisut	150 18 03	5882.9	6433.4	3.65
Marrowstone Point	48 06 13.13	E 0 03 41.27	110 30 50	Point Hudson	290 28 10	4726.9	5169.2	2.94
			133 15 39	Point Wilson	313 12 42	6745.0	7376.1	4.19
Lagoon	48 04 49.57	0 08 17.14	114 21 23	Marrowstone Point	294 17 58	6264.0	6850.1	3.89
			150 16 20	Admiralty Head	330 13 27	9675.0	10580.3	6.01
Nodule Point	48 01 55.90	0 04 55.42	169 04 22	Marrowstone Point	349 03 27	8091.1	8848.2	5.03
			217 53 10	Lagoon	37 55 40	6798.0	7434.1	4.22
Bush Point	48 01 55.57	0 08 37.92	175 25 29	Lagoon	355 25 14	5391.0	5895.4	3.35
			142 21 50	Marrowstone Point	322 18 10	10048.8	10989.1	6.24
Basalt Point	47 57 36.75	0 04 27.66	184 06 34	Nodule Point	4 06 55	8023 7	8774.5	4.98
			212 57 32	Bush Point	33 00 38	9528.7	10420.3	5.92
Double Bluff	47 58 26.29	0 11 57.14	126 34 04	Nodule Point	306 28 51	10876.4	11894.1	6.76
			147 26 58	Bush Point	327 24 30	7669.4	8387.0	4.76
Foulweather Bluff	47 56 30.02	0 08 46.53	154 33 50	Nodule Point	334 30 58	11146.2	12189.1	6.92
			178 59 02	Bush Point	358 58 55	10055.3	10996.2	6.25
Duplicate	47 58 07.07	0 12 16.64	55 30 27	Foulweather Bluff	235 27 51	6058.2	6625.1	3.76
			127 44 25	Nodule Point	307 38 57	11557.2	12638.6	7 18
Point No Point	47 54 48.04	0 13 28.35	164 19 29	Double Bluff	344 18 21	7000.7	7655.7	4.35
			166 23 45	Duplicate	346 22 52	6324.0	6915.7	3.93
Scatchet Head	47 54 57.15	0 19 14.46	87 47 40	Point No Point	267 43 23	7190.9	7863.7	4.47
			124 07 16	Duplicate	304 02 06	10467.3	11446.7	6 50
Apple Cove	47 48 57.90	0 16 05.84	163 10 39	Point No Point	343 08 42	11297.5	12354.6	7.02
			199 26 19	Scatchet Head	19 28 39	11766.3	12867.3	7.31
Point Wells	47 46 57.00	0 21 14.19	120 13 41	Apple Cove	300 09 53	7423.2	8117.8	4.61
			170 29 01	Scatchet Head	350 27 33	15035.3	16442.2	9.34
President	47 45 51.33	0 16 46.20	171 42 39	Apple Cove	351 42 09	5822.6	6367.4	3.62
			249 59 42	Point Wells	70 03 00	5936.2	6491.6	3.69
Meadow	47 41 42.48	0 20 42.63	147 21 49	President	327 18 54	9128.2	9982.3	5 67
			183 52 07	Point Wells	3 52 31	9735.2	10646.1	6.05
Elder	47 41 40.53	0 14 48.82	219 21 37	Point Wells	39 26 22	12647.5	13830.9	7.86
			269 29 46	Meadow	89 34 08	7376.7	8066.9	4.58
Yemoalt	47 38 04.19	0 15 39.95	170 56 05	Elder	350 55 27	6765.5	7398.5	4.20
			223 05 45	Meadow	43 09 29	9236.4	10100.6	5.74
Magnolia	47 38 34.80	0 20 05.88	80 21 36	Yemoalt	260 18 20	5630.2	6157.0	3.50
			130 57 54	Elder	310 54 00	8754.1	9573.2	5.44
Restoration Point	47 35 05.78	0 16 17.78	171 50 34	Yemoalt	351 50 06	5565.5	6086.3	3.46
			216 24 02	Magnolia	36 26 50	8021.7	8772.3	4.98
Battery Point	47 34 37.04	0 19 51.24	182 22 59	Magnolia	2 23 10	7348.6	8036.2	4.56
			101 16 36	Restoration Point	2 81 13	4547.5	4923.0	2.83
Hydrographic Signal	48 05 30.84	0 01 01.90	159 05 04	Point Hudson	339 04 23	3169.8	3466.4	1.97
			237 47 46	Kilisut	57 48 33	1533.5	1677.0	0.95
Long Spit	48 05 30.83	0 01 02.03	24 51 31	Walan	204 51 02	1926.6	2106.9	1.20
			125 24 29	N. E. Base	305 22 45	3558.4	3891.4	2.21
Ebey's House, southwest end	48 07 11.33	E. 0 00 10.00	22 13 41	Point Hudson	202 13 39	153.9	168.3	0.09
			169 04 01	Point Wilson	349 03 41	2875.4	3144.5	1.79
Point Partridge	48 12 59.31	W. 0 00 33.74	357 24 30	Point Wilson	177 24 43	7931.9	8674.1	4.93
			355 33 24	Point Hudson	175 33 54	10922.3	11944.3	6.79

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section XI.—Admiralty Inlet. Sketch K, No. 34.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Point Ross	48 08 38.18	W. 0 02 01.55	192 39 59	Point Partridge	12 41 04	8266.0	9039.4	5.14
			260 26 27	Admiralty Head	80 31 15	8099.8	8857.7	5.03
Dungeness	48 10 59.60	0 21 44.32	280 00 38	Point Ross	100 15 19	24824.6	27147.4	15.42
			261 50 47	Point Partridge	82 06 34	26492.5	28971.4	16.46
Dungeness (new) Light-house	48 10 58.96	0 21 34.06	280 03 10	Point Ross	100 17 44	24612.5	26915.5	15.29
			261 44 24	Point Partridge	82 00 04	26285.6	28745.1	16.33
Kala Point	48 03 31.82	W. 0 00 56.53	145 56 03	S. W. Base	325 54 30	4608.7	5039.9	2.86
			220 27 33	Walan	40 28 32	2533.4	2770.5	1.57
Crane	48 03 00.35	E. 0 00 32.41	117 50 09	Kala Point	297 49 03	2082.4	2277.3	1.29
			176 06 58	Walan	356 06 51	2906.1	3178.0	1.81
Tongue	48 02 10.09	W. 0 00 09.70	158 59 19	Kala Point	338 58 44	2704.1	2957.1	1.68
			209 19 35	Crane	29 20 06	1780.4	1947.0	1.11
Rock	48 02 23.41	E. 0 00 53.24	72 29 11	Tongue	252 28 24	1367.0	1494.9	0.85
			159 17 25	Crane	339 17 10	1219.4	1333.5	0.76
Head	48 02 04.68	0 00 49.44	97 45 45	Tongue	277 45 01	1236.3	1352.0	0.77
			168 24 28	Crane	348 24 15	1754.8	1919.0	1.09
Island	48 01 54.83	0 00 11.00	137 42 26	Tongue	317 42 11	637.2	696.8	0.39
			192 21 28	Crane	12 21 44	2071.5	2265.3	1.29
Beach, (1)	48 09 50.02	0 05 41.90	340 54 08	Lagoon	160 56 04	9818.4	10737.1	6.10
			20 25 55	Marrowstone Point	200 24 25	7147.2	7816.0	4.44
Beach, (2)	48 09 55.43	0 07 03.01	350 46 34	Lagoon	170 47 29	9569.4	10464.8	5.94
			31 17 50	Marrowstone Point	211 15 20	8032.5	8784.1	4.99
Robertson	48 09 31.24	0 08 12.32	359 20 30	Lagoon	179 20 34	8699.5	9513.5	5.41
			42 30 52	Marrowstone Point	222 27 30	8296.8	9073.1	5.16
Shipyard	48 08 32.75	0 08 49.32	55 56 18	Marrowstone Point	235 52 29	7692.0	8411.7	4.78
			5 30 58	Lagoon	185 30 34	6924.4	7572.3	4.30
Doyle	48 07 10.38	0 09 04.61	125 03 05	Admiralty Head	304 59 37	7058.8	7719.3	4.39
			12 43 38	Lagoon	192 43 03	4458.0	4875.1	2.77
Craven, (1)	48 04 29.09	0 03 54.01	184 03 06	Admiralty Head	4 03 29	9055.0	9902.3	5.63
			175 18 49	Marrowstone Point	355 18 39	3224.0	3525.7	2.00
Craven, (2)	48 03 24.74	0 04 03.58	182 17 53	Admiralty Head	2 18 09	11028.3	12060.2	6.85
			174 55 45	Marrowstone Point	354 55 28	5220.9	5709.4	3.24
Slide	48 00 40.74	0 10 13.92	109 24 41	Nodule Point	289 20 44	6995.0	7649.5	4.35
			332 43 29	Double Bluff	152 44 46	4671.1	5108.2	2.90
Colvos Rock	47 57 11.64	0 04 48.09	208 29 35	Bush Point	28 32 26	9979.0	10912.7	6.20
			255 25 55	Double Bluff	75 31 14	9192.7	10052.9	5.71
Sayward	47 59 57.39	0 12 23.77	66 18 07	Basalt Point	246 12 13	10785.4	11794.6	6.70
			111 32 50	Nodule Point	291 27 17	9985.0	10919.3	6.20
Neck	47 55 18.03	0 09 59.26	172 11 13	Bush Point	352 10 13	12392.4	13552.0	7.70
			152 53 02	Nodule Point	332 49 16	13808.3	15100.3	8.58
Briar	47 58 24.32	0 04 03.36	221 04 04	Bush Point	41 07 28	8657.0	9467.0	5.38
			269 35 48	Double Bluff	89 41 40	9825.0	10744.3	6.10
Limestone	47 58 51.94	0 02 33.51	233 03 35	Bush Point	53 08 06	9444.3	10328.0	5.87
			273 49 12	Double Bluff	93 56 11	11714.1	12810.2	7.28
Liplip	48 01 06.92	0 04 49.48	299 11 16	Double Bluff	119 16 34	10158.1	11108.6	6.31
			3 59 25	Basalt Point	183 59 09	6506.1	7114.9	4.04
Canal	47 55 59.68	0 07 49.05	125 40 40	Basalt Point	305 38 10	5142.7	5623.9	3.19
			185 15 45	Bush Point	5 16 21	11037.3	12070.1	6.86
Tala Point, 1855	47 55 54.71	0 05 33.11	156 41 33	Basalt Point	336 40 44	3431.5	3752.6	2.13
			239 31 24	Double Bluff	59 36 09	9240.2	10104.8	5.74
Tala Point, 1856	47 55 54.60	0 05 33.00	156 44 55	Basalt Point	336 44 07	3433.8	3755.1	2.13
			266 48 19	Canal	86 50 00	2827.8	3092.4	1.76
Olele	47 58 08.80	0 03 58.27	219 05 04	Bush Point	39 38 32	9090.7	9941.3	5.65
			266 50 18	Double Bluff	86 56 14	9945.5	10876.1	6.18
Oak Bay	48 00 35.22	0 03 42.62	291 10 33	Double Bluff	111 16 40	10997.3	12026.3	6.83
			350 22 49	Basalt Point	170 23 23	5589.9	6112.9	3.47
House between Lagoon and Bush Point.	48 03 49.86	0 08 57.00	6 24 08	Bush Point	186 23 54	3551.3	3883.6	2.21
			124 07 22	Marrowstone Point	304 03 27	7892.7	8631.2	4.90
Hood's Head	47 53 19.33	0 08 22.87	143 40 57	Tala Point, 1856	323 38 51	5952.4	6509.4	3.70
			171 56 00	Canal	351 55 35	5001.5	5469.5	3.11
Pond	47 55 36.54	E. 0 08 00.84	353 50 17	Hood's Head	173 50 33	4262.0	4660.8	2.65
			100 18 59	Tala Point, 1856	280 17 09	3118.7	3410.5	1.94

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UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section XI.—Admiralty Inlet. Sketch K, No. 34.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Clay Bank	47 54 19.06	E. 0 09 44.50	42 35 41 119 29 53	Hood's Head Tala Point, 1856	222 34 40 299 26 46	2505.3 5996.9	2739.7 6558.0	1.56 3.72
Adam's Apple	47 55 20.88	0 08 54.19	9 49 52 104 01 20	Hood's Head Tala Point, 1856	189 49 29 283 58 51	3809.7 4303.6	4166.2 4706.3	2.37 2.67
Peninsula, (2)	47 54 36.75	0 05 46.24	276 16 41 306 18 07	Clay Bank Hood's Head	96 19 38 126 20 03	4977.3 4037.0	5443.0 4414.7	3.09 2.51
Barnacle	47 53 11.82	0 10 14.02	95 45 08 163 33 30	Hood's Head Clay Bank	275 43 46 343 33 08	2320.3 2165.2	2537.4 2367.8	1.44 1.34
Gamble, (2)	47 51 32.31	0 10 36.89	139 53 59 171 12 36	Hood's Head Barnacle	319 52 20 351 12 19	4317.9 3109.7	4721.9 3400.7	2.68 1.93
Gamble, (1)	47 51 27.03	0 10 00.45	149 42 07 257 51 51	Hood's Head Gamble, (2)	329 40 55 77 52 18	4017.5 774.7	4393.4 847.2	2.50 0.48
Salsbury Point	47 51 28.79	0 08 34.22	176 02 57 213 04 54	Hood's Head Barnacle	356 02 49 33 06 08	3422.0 3797.8	3742.2 4153.1	2.13 2.36
Termination Point	47 52 08.74	0 06 55.87	244 39 21 283 44 27	Barnacle Gamble, (2)	64 41 48 103 47 11	4554.3 4728.9	4980.4 5171.4	2.83 2.94
Southwest Point, Hood's Head	47 52 46.28	0 07 49.21	214 24 27 303 14 00	Hood's Head Gamble, (2)	34 24 52 123 16 04	1234.4 4166.4	1349.9 4556.2	0.77 2.59
Crab-apple	47 55 11.65	0 12 10.32	177 23 47 181 23 02	Double Bluff Duplicate	357 23 37 1 23 07	6017.2 5418.9	6580.2 5925.9	3.74 3.37
Indian Point	47 55 51.90	0 18 20 96	72 02 35 118 56 52	Point no Point Duplicate	251 58 58 298 52 21	6386.5 8634.7	6984.1 9442.6	3.97 5.36
Gully	47 58 27.18	0 13 44.47	2 49 48 59 41 05	Point no Point Foulweather Bluff	182 49 36 239 37 24	6775.4 7161.2	7409.4 7831.3	4 21 4.45
Eagle, (2)	47 57 11.48	0 18 29.04	54 39 43 102 34 09	Point no Point Duplicate	234 36 00 282 29 31	7652.4 7912.9	8368.4 8653.3	4.75 4.92
Deer Lagoon	47 59 32.50	0 15 44.17	334 27 58 17 47 49	Indian Point Point no Point	154 29 54 197 46 08	7549.2 9225.6	8255.6 10088.8	4.69 5.73
Clay	47 58 39.75	0 17 19.91	346 15 54 33 54 07	Indian Point Point no Point	166 16 39 213 51 15	5336.2 8619.2	5835.5 9425.7	3.32 5.35
Scatchet, east	47 54 29.67	0 21 32.47	33 33 34 93 16 49	Apple Cove Point no Point	213 29 32 273 10 50	12290.4 10067.5	13440.4 11009.5	7.64 6.25
Pilot Point	47 52 52.00	0 14 13.40	238 14 47 342 04 21	Scatchet Head Apple Cove	58 18 30 162 05 44	7350.3 7597.9	8038.1 8308.8	4.57 4.72
Run	47 51 40.92	0 24 57.54	65 34 15 130 24 47	Apple Cove Scatchet Head	245 27 41 310 20 32	12119.0 9354 6	13253.0 10229.9	7.53 5.81
Granite	47 50 28.36	0 23 51.27	73 56 56 145 18 48	Apple Cove Scatchet Head	253 51 11 325 15 23	10073.9 10098.3	11016.5 11043.2	6.26 6.27
Water	47 49 22.79	0 22 37.11	84 38 45 157 50 06	Apple Cove Scatchet Head	264 33 55 337 47 36	8174.2 11151.4	8939.1 12194.8	5.08 6.93
Log	47 48 31.55	0 21 32.17	96 52 14 166 30 02	Apple Cove Scatchet Head	276 48 12 346 28 20	6836.8 12247.2	7476.5 13393.2	4.25 7.61
Rose	47 51 21.69	0 14 33.29	221 14 48 336 33 42	Scatchet Head Apple Cove	41 18 17 156 34 51	8853.4 4839.5	9681.8 5292.3	5.50 3.01
Sycamore	47 50 18.79	0 14 38.35	213 41 13 323 55 16	Scatchet Head Apple Cove	33 44 38 143 56 21	10334.7 3090.3	11301.7 3379.5	6.42 1.92
Spring	47 52 55.62	0 25 03.22	24 48 54 56 44 34	Water Apple Cove	204 47 06 236 37 56	7240.5 13367.0	7918.0 14617.7	4.50 8.31
Possession	47 54 30.83	0 22 27.76	312 18 28 358 49 47	Spring Water	132 20 23 178 49 54	4366.8 9515.0	4775.4 10405.3	2.71 5.91
Buzzard	47 56 18.73	0 23 30.78	342 58 39 21 26 25	Spring Possession	162 59 48 201 25 38	6559 5 3579 7	7173.3 3914.6	4.08 2.22
Sound	47 54 53.40	0 25 48.23	80 30 46 132 44 35	Possession Buzzard	260 28 17 312 42 53	4220.0 3883.6	4614.9 4247.0	2.62 2.41
Point Elliott	47 56 51.59	0 26 35.10	14 55 46 75 09 31	Sound Buzzard	194 55 11 255 07 14	3777.3 3956.8	4130.7 4327.0	2.35 2.46
Hawk	47 57 33.50	0 24 04.50	292 29 17 336 27 46	Point Elliot Sound	112 31 09 156 29 03	3381.8 5392.5	3698.2 5897.1	2.10 3.35
North gable of north house, at entrance.	47 54 50.74	0 22 29.08	233 48 38 268 50 23	Point Elliott Sound	53 51 41 88 52 51	6324.6 4135.3	6916.4 4522.2	3.93 2.57
First stake south of Buzzard	47 55 26.31	E. 0 22 28.49	218 36 31 283 45 04	Buzzard Sound	38 37 17 103 47 32	2071.8 4269.2	2265.6 4668.7	1.29 2.65

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Section XI.—Admiralty Inlet. Sketch K, No. 34.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
North gable of north house, near Possession.	47 54 50.75	E. 0 22 29.11	205 13 11	Buzzard	25 13 57	3003.6	3284.6	1.87
			317 59 25	Spring	138 01 19	4783.6	5231.2	2.97
Blazed Tree	47 46 25.06	0 21 25.80	79 53 05	President	259 49 38	5913.7	6467.0	3.67
			125 22 01	Apple Cove	305 18 04	8161.5	8925.2	5.07
South Apple	47 46 56.16	0 16 03.01	180 53 43	Apple Cove	0 53 45	3760.0	4111.8	2.34
			269 44 18	Point Wells	89 48 08	6476.8	7082.8	4.02
North Apple	47 48 07.18	0 15 38.62	287 12 21	Point Wells	107 16 30	7311.7	7995.8	4.54
			341 27 32	President	161 28 22	4424.6	4838.6	2.75
Robin	47 44 58.05	0 22 06.42	16 07 57	Meadow	196 06 55	6286.9	6875.2	3.91
			103 53 31	President	283 49 34	6868.4	7511.1	4.27
Grave	47 42 49.84	0 22 17.96	129 04 43	President	309 00 22	8898.0	9730.6	5.53
			170 08 08	Point Wells	350 07 18	7747.3	8472.2	4.81
Crow	47 40 42.81	0 14 33.25	215 49 17	Point Wells	35 54 14	14258.6	15592.8	8.86
			256 30 31	Meadow	76 35 04	7919.1	8660.1	4.92
Point Monroe	47 42 27.41	0 14 31.22	225 11 31	Point Wells	45 16 29	11882.0	12994.2	7.34
			280 07 21	Meadow	100 11 56	7865.9	8601.9	4.89
Skiff	47 29 48.27	0 15 05.59	174 14 31	Elder	354 14 19	3484.5	3810.5	2.17
			347 25 15	Yemoalt	167 25 40	3293.2	3601.3	2.05
Foster	47 44 43.11	0 15 32.46	310 45 46	Meadow	130 49 36	8537.7	9336.6	5.30
			16 56 33	Point Monroe	196 55 48	4380.5	4790.4	2.72
Drift	47 42 00.88	0 14 46.64	221 23 54	Point Wells	41 28 41	12198.1	13339.5	7.58
			274 20 35	Meadow	94 24 58	7443.4	8139.9	4.62
Creek	47 40 28.84	0 20 41.21	115 25 49	Point Monroe	295 21 15	8539.2	9338.2	5.30
			140 41 47	Foster	320 37 59	10150.8	11100.6	6.31
Point Jefferson	47 44 57.38	0 16 38.37	237 13 15	Point Wells	57 16 39	6828.3	7467.2	4.24
			319 45 17	Meadow	139 48 18	7883.2	8620.8	4.90
Middle	47 45 28.36	0 16 48.92	243 36 20	Point Wells	63 39 36	6163.9	6740.6	3.83
			325 03 22	Meadow	145 06 15	8507.1	9303.1	5.29
Tide	47 43 11.44	0 12 23.96	234 17 46	Foster	54 20 06	4852.9	5307.0	3.01
			297 00 09	Point Monroe	117 01 44	2993.4	3273.5	1.86
Reservation	47 43 33.39	0 11 40.96	245 55 13	Foster	65 58 04	5281.6	5775.8	3.28
			299 50 57	Point Monroe	119 53 03	4091.7	4474.5	2.54
Cherry	47 44 09.02	0 12 05.13	256 16 52	Foster	76 19 25	4445.2	4861.1	2.76
			315 51 13	Point Monroe	135 53 01	4371.9	4781.0	2.72
Clements	47 44 55.15	0 12 35.59	332 09 08	Point Monroe	152 10 34	5159.5	5642.3	3.21
			4 35 11	Tide	184 35 02	3213.0	3513.6	2.00
West Point	47 39 47.22	0 18 56.43	124 08 51	Elder	304 05 48	6237.7	6821.3	3.88
			52 12 22	Yemoalt	232 09 57	5189.5	5675.1	3.22
Duwamish	47 35 44.61	0 21 48.82	80 11 46	Restoration Point	260 07 42	7018.5	7675.2	4.36
			119 16 09	Yemoalt	299 11 35	8826.0	9651.8	5.48
Alder	47 37 56.96	0 21 25.38	91 48 30	Yemoalt	271 44 15	7213.7	7888.7	4.48
			353 10 14	Duwamish	173 10 31	4116.0	4501.1	2.56
Swallow	47 37 46.44	0 22 51.16	58 54 45	Restoration Point	238 49 54	9596.9	10494.9	5.96
			93 31 46	Yemoalt	273 26 27	9017.5	9861.3	5.60
Leaning Tree	47 37 01.77	0 23 46.44	45 53 10	Duwamish	225 51 43	3422.0	3742.2	2.13
			120 04 30	Alder	300 02 46	3402.3	3720.7	2.11
Cabin	47 35 40.84	0 22 03.91	169 10 11	Alder	349 09 43	4279.5	4679.9	2.66
			220 34 51	Leaning Tree	40 36 07	3290.8	3598.7	2.04
Seattle	47 36 01.23	0 24 57.62	80 10 32	Cabin	260 08 24	3682.6	4027.2	2.29
			141 31 06	Leaning Tree	321 30 13	2388.4	2611.9	1.48
Trail	47 34 37.42	0 25 47.86	112 44 09	Cabin	292 41 24	5072.2	5546.8	3.15
			150 22 21	Leaning Tree	330 20 51	5128.5	5608.4	3.19
Gull	47 34 16.82	0 24 39.54	128 36 19	Cabin	308 34 24	4160.0	4549.2	2.58
			167 43 14	Leaning Tree	347 42 35	5213.0	5700.8	3.24
Buttonwood	47 34 20.92	0 23 35.95	142 05 08	Cabin	322 04 00	3128.8	3421.6	1.94
			182 31 27	Leaning Tree	2 31 35	4971.9	5437.1	3.09
Hydrographic Signal	47 35 12.30	0 22 29.71	205 21 11	Leaning Tree	25 22 08	3741.1	4091.1	2.32
			148 33 33	Cabin	328 33 14	1033.2	1129.9	0.64
Cabin south end of Buttonwood	47 34 12.76	0 23 43.44	180 41 16	Leaning Tree	0 41 18	5219.4	5707.8	3.24
			204 49 21	Seattle	24 50 16	3690.7	4036.0	2.29
Hydrographic Signal on Tree	47 37 56.38	E. 0 21 35.24	356 00 40	Duwamish	176 00 50	4078.8	4460.4	2.53
			301 36 20	Leaning Tree	121 37 57	3216.6	3517.6	2.00

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Section XI.—Admiralty Inlet. Sketch K, No. 34.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	Metres.	Yards.	Miles.
Hydrographic Signal on Spit	47 37 59.87	E. 0 21 51.90	306 51 46	Leaning Tree	126 53 10	2989.4	3269.1	1.86
			52 25 01	Restoration Point	232 20 54	8808.5	9632.7	5.47
Elm	47 35 03.51	0 20 57.50	130 06 30	Yemoalt	310 02 35	8666.2	9477.1	5.38
			170 37 29	Magnolia	350 36 51	6613.2	7232.0	4.11
Cliff	47 35 22.76	0 15 34.78	181 14 23	Yemoalt	1 14 27	4986.0	5452.5	3.10
			223 38 20	Magnolia	43 41 40	8198.2	8965.3	5.09
Cobble	47 36 41.17	0 15 11.97	240 12 17	Magnolia	60 15 54	7068.2	7729.6	4.39
			334 58 27	Restoration Point	154 59 16	3250.6	3554.8	2.02
Wing	47 37 18.40	0 15 33.84	247 24 38	Magnolia	67 27 59	6149.1	6724.5	3.82
			347 21 52	Restoration Point	167 22 24	4197.0	4589.7	2.61
Point Williams, marked tree	47 31 52.29	0 21 00.86	135 18 33	Restoration Point	315 15 04	8409.2	9196.0	5.22
			164 02 42	Battery Point	344 01 51	5291.7	5786.8	3.29
Brace Point	47 31 05.46	0 21 07.27	140 50 01	Restoration Point	320 46 27	9576.0	10472.0	5.95
			166 20 07	Battery Point	346 19 11	6724.3	7353.5	4.18
Dolphin Point	47 30 14.32	0 17 56.92	167 02 27	Restoration Point	347 01 14	9236.1	10100.3	5.74
			196 24 21	Battery Point	16 25 45	8457.8	9249.2	5.26
Tatugh, (1)	47 33 33.01	0 16 16.26	180 38 21	Restoration Point	0 38 22	2865.0	3133.1	1.78
			246 13 30	Battery Point	66 16 09	4908.9	5368.2	3.05
Stake on spit near Alder	47 38 08.57	E. 0 22 08.69	5 20 12	Duwamish	185 19 57	4464.9	4882.7	2.77
			52 25 43	Restoration Point	232 21 24	9151.5	10007.8	5.69
Eastern sharp peak of Olympus	47 46 26.54	W. 0 22 35.27	252 55 32	Scatchet Head	73 26 33	54504.8	59604.8	33.87
			268 44 42	Point Wells	89 17 09	54741.3	59863.4	34.01
Tatugh, (2)	47 32 32.17	E. 0 16 15.83	180 29 31	Restoration Point	0 29 32	4743.9	5187.8	2.95
			229 23 59	Battery Point	49 26 38	5928.2	6482.9	3.68
Vashon Point	47 30 39.43	0 16 29.01	178 22 00	Restoration Point	358 21 52	8228.8	8998.8	5.11
			175 28 31	Tatugh, (2)	355 28 21	3492.1	3818.9	2.17
Point Beals	47 28 01.62	0 19 02.06	161 35 59	Dolphin Point	341 35 11	4318.8	4722.9	2.68
			204 45 51	Brace Point	24 47 23	6252.4	6837.4	3.88
Point Pully	47 27 07.28	0 22 11.52	137 19 28	Dolphin Point	317 16 21	7859.3	8594.7	4.88
			112 56 40	Point Beals	292 54 21	4307.8	4710.9	2.68
South Bainbridge	47 34 35.56	0 14 50.70	269 33 05	Battery Point	89 36 47	6280.3	6867.9	3.90
			334 57 24	Tatugh, (2)	154 58 27	4205.4	4598.9	2.61
Northwest Blake	47 32 43.90	0 14 43.09	204 18 02	Restoration Point	24 19 12	4807.8	5257.7	2.99
			182 38 19	South Bainbridge	2 38 25	3451.7	3774.7	2.14
Orchard	47 33 59.03	0 13 07.97	242 31 17	Restoration Point	62 33 37	4470.1	4888.4	2.78
			319 23 41	N. W. Blake	139 24 51	3055.7	3341.6	1.90
Southwest Bainbridge	47 34 36.93	0 13 38.52	338 51 09	N. W. Blake	158 51 57	3742.2	4092.4	2.32
			28 37 10	Orchard	208 36 47	1332.9	1457.6	0.83
Otter	47 31 27.74	0 13 48.99	169 36 01	Orchard	349 35 31	4750.1	5194.6	2.95
			205 40 57	N. W. Blake	25 41 37	2609.7	2853.9	1.62
Southwest Blake	47 32 02.88	0 15 10.53	57 32 26	Otter	237 31 26	2021.2	2210.3	1.26
			155 38 06	N. W. Blake	335 37 46	1390.6	1520.7	0.86
Fly	47 31 09.75	0 14 51.76	112 56 05	Otter	292 55 19	1425.5	1558.9	0.88
			294 42 09	Vashon Point	114 43 21	2239.5	2449.0	1.39
Point Southworth	47 30 41.54	0 15 20.86	272 36 15	Vashon Point	92 37 05	1427.3	1560.8	0.89
			264 08 46	Brace Point	84 13 01	7284.4	7966.0	4.52
Post	47 32 30.36	0 12 37.63	322 19 45	Otter	142 20 38	2442.6	2671.2	1.52
			193 02 12	Orchard	13 02 34	2810.8	3073.8	1.75
Point Peter	47 28 36.66	0 15 11.73	182 50 13	Point Southworth	2 50 20	3861.1	4222.4	2.40
			203 05 43	Vashon Point	23 06 40	4121.9	4507.6	2.56
Point Paul	47 28 38.51	0 13 40.58	223 19 59	Vashon Point	43 22 03	5134.9	5615.4	3.19
			271 42 44	Point Peter	91 43 51	1909.0	2087.6	1.18
James' Point	47 27 45.54	0 14 32.41	146 26 50	Point Paul	326 26 11	1963.2	2146.9	1.22
			207 32 07	Point Peter	27 32 36	1780.4	1947.0	1.11
Point Command	47 27 24.30	0 13 12.30	194 29 09	Point Paul	14 29 30	2367.0	2588.5	1.47
			228 12 26	Point Peter	48 13 54	3353.5	3667.3	2.08
Flora	47 27 19.55	0 14 21.16	95 48 36	Point Command	275 47 45	1449.7	1585.3	0.90
			160 47 24	Point Paul	340 46 54	2582.1	2823.7	1.60
Point Prospect	47 25 51.20	0 13 07.31	182 04 55	Point Command	2 04 59	2876.9	3146.1	1.79
			209 32 50	Flora	29 33 44	3136.6	3430.1	1.95
Andrew	47 26 29.56	E. 0 14 13.61	142 46 41	Point Command	322 45 56	2122.9	2321.5	1.32
			49 32 52	Point Prospect	229 32 03	1825.8	1996.6	1.13

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section XI.—Admiralty Inlet. Sketch K, No. 34.

Name of station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Thistle	47 25 09.90	E. 0 14 11.23	133 35 42	Point Prospect	313 34 55	1849.3	2022.3	1.15
			181 09 53	Andrew	1 09 55	2460.3	2690.5	1.53
Baker	47 26 24.64	0 13 02.41	264 10 42	Andrew	84 11 34	1499.5	1639.8	0.93
			354 19 13	Point Prospect	174 19 17	1038.0	1135.1	0.64
Marked Tree, (17)	47 26 57.33	0 14 14.11	122 45 19	Point Command	302 44 34	1539.4	1683.4	0.96
			167 20 15	Point Paul	347 19 50	3202.4	3502.0	1.99
Bright Stump	47 28 02.71	0 14 53.46	39 43 48	James' Point	219 43 33	689.5	754.0	0.43
			60 46 09	Point Command	240 44 54	2427.8	2655.0	1.51
Marked Tree, (16)	47 25 50.17	0 14 33.24	91 01 08	Point Prospect	271 00 05	1800.9	1969.4	1.12
			149 45 09	Point Command	329 44 09	3365.3	3680.2	2.09
Marked Tree, (14)	47 28 15.74	0 13 06.83	256 08 34	Point Peter	76 08 06	2693.6	2945.6	1.67
			297 28 54	James' Point	117 29 57	2020.3	2209.3	1.25
Rock	47 27 43.72	0 13 09.75	268 08 17	James' Point	68 09 18	1732.0	1894.1	1.08
			296 30 32	Flora	116 31 25	1671.4	1827.8	1.04
Rosa	47 29 21.20	0 13 56.74	232 48 52	Vashon Point	52 50 44	3998.7	4372.8	2.48
			311 13 04	Point Peter	131 13 59	2087.0	2282.3	1.30
Marked Tree, (15)	47 29 55.65	0 14 38.31	239 42 58	Vashon Point	59 44 20	2682.0	2933.0	1.67
			343 59 47	Point Peter	164 00 12	2537.6	2775.0	1.58
Fern	47 29 23.11	0 16 16.23	43 16 25	Point Peter	223 15 37	1969.9	2154.2	1.22
			154 26 29	Point Southworth	334 25 48	2684.8	2936.0	1.67
Southeast Blake	47 31 54.79	0 15 57.46	344 09 42	Vashon Point	164 10 05	2418.8	2645.1	1.50
			18 41 59	Point Southworth	198 41 32	2388.0	2611.4	1.48
House in Bight, door	47 31 30.77	0 12 15.82	196 43 48	S. W. Bainbridge	16 44 49	6002.7	6564.4	3.73
			233 44 10	N. W. Blake	53 45 59	3818.8	4176.1	2.37
Jay	47 33 35.29	0 20 53.73	71 28 52	Tatugh, (2)	251 25 27	6127.9	6701.3	3.81
			145 36 16	Battery Point	325 35 30	2311.3	2527.6	1.43
Marked Tree, (1)	47 32 46.29	0 21 07.32	85 56 13	Tatugh, (2)	265 52 38	6110.7	6682.5	3.80
			40 20 02	Dolphin Point	220 17 41	6154.6	6730.5	3.82
Point Williams	47 31 51.92	0 21 00.06	164 15 16	Battery Point	344 14 25	5297.9	5793.6	3.29
			135 26 33	Restoration Point	315 23 05	8435.7	9225.0	5.24
Marked Tree, (18)	47 30 31.95	0 17 20.01	171 15 41	Restoration Point	351 14 55	8555.6	9356.2	5.31
			202 39 25	Battery Point	22 41 17	8202.4	8969.9	5.09
Bright Stump	47 34 14.09	0 20 27.91	59 10 34	Tatugh, (2)	239 07 28	6137.8	6712.1	3.81
			107 00 34	Restoration Point	285 57 34	5464.9	5976.2	3.39
Granite Boulder	47 32 06.11	0 21 13.97	97 23 01	Tatugh, (2)	277 19 21	6285.9	6874.1	3.91
			159 39 04	Battery Point	339 38 03	4971.2	5436.3	3.09
Marked Tree, (2)	47 30 20.75	0 21 45.78	38 35 39	Point Beals	218 33 38	5495.4	6009.6	3.41
			87 39 05	Dolphin Point	267 36 16	4792.9	5241.4	2.98
Marked Tree, (3)	47 28 45.94	0 18 09.47	174 30 05	Dolphin Point	354 29 56	2742.0	2998.6	1.70
			300 59 07	Point Pully	121 02 05	5913.4	6466.7	3.67
Snake	47 27 54.97	0 22 54.35	124 40 53	Dolphin Point	304 37 14	7568.4	8276.6	4.70
			92 26 36	Point Beals	272 23 45	4868.3	5323.8	3.02
Seal	47 29 22.89	0 17 25.35	235 40 41	Brace Point	55 43 25	5620.9	6146.8	3.49
			304 55 09	Point Pully	124 58 40	7309.9	7993.9	4.54
Lupin	47 29 27.65	0 23 07.47	15 07 50	Point Pully	135 07 09	4490.1	4910.2	2.79
			62 40 54	Point Beals	242 37 58	5783.7	6324.9	3.59
Rain	47 27 02.36	0 18 38.33	202 32 15	Brace Point	22 34 05	8128.6	8889.2	5.05
			195 11 30	Point Beals	15 11 47	1896.4	2073.8	1.18
Point Hyer	47 25 26.46	0 19 15.65	176 36 13	Point Beals	356 36 03	4799.9	5249.0	2.98
			229 46 59	Point Pully	49 49 08	4823.7	5275.0	3.00
Raspberry	47 24 01.06	0 21 18.40	158 58 49	Point Beals	338 57 09	7958.7	8703.4	4.94
			190 57 01	Point Pully	10 57 40	5857.2	6405.3	3.64
Marked Tree, (4)	47 24 07.15	0 19 49.22	172 14 04	Point Beals	352 13 29	7307.5	7991.3	4.54
			208 10 43	Point Pully	28 12 28	6311.3	6901.8	3.92
Charred Tree	47 29 57.80	E. 0 17 33.13	312 04 03	Point Pully	132 07 28	7854.5	8589.4	4.88
			332 33 54	Point Beals	152 35 00	4041.7	4419.9	2.51

APPENDIX No. 21.

Report of Prof. O. M. Mitchel, director, on the moon culminations observed for the U. S. Coast Survey at Cincinnati observatory.

CINCINNATI, *Ohio, September* 24, 1859.

DEAR SIR: I have to report the observation of forty-nine moon culminations made during the past twelve months.

The mode of observation and record remains the same as in the past years, the only change being the introduction of a new system of wires into the transit instrument on the 5th of July last. The number of wires is the same as before used, (fifteen,) but they are grouped differently, being now in five groups of three wires each. The equatorial distance between groups is about eight seconds of time, and the interval between the wires of each group is four seconds equatorial. The reduction from mean to middle wire has been obtained from a discussion of fifty-nine observations of stars within twenty degrees of the equator.

The observations were made and reduced by my assistant, Henry Twitchell, esq., who has charge of the transit.

Yours, respectfully,

O. M. MITCHEL.

Dr. A. D. BACHE,
Supt. U. S. Coast Survey, Washington, D. C.

APPENDIX No. 22.

Discussion of the magnetic and meteorological observations made at the Girard College observatory, Philadelphia, in 1840, 1841, 1842, 1843, 1844, *and* 1845. *Part I. Investigation of the eleven-year period in the amplitude of the solar-diurnal variation, and of the disturbances of the magnetic declination. By A. D. Bache, LL.D.*

INTRODUCTION.

In co-operation with the scheme adopted at the British colonial observatories, a series of magnetic and meteorological observations were made at the Girard College magnetic observatory, in Philadelphia, with instruments purchased under the direction of the trustees of the college, the observations being made under the patronage of the American Philosophical Society, and finally completed for the use of the Topographical Bureau of the War Department.[1]

These observations were made under my immediate direction, and were afterwards left under my general superintendence. The series commenced in May, 1840, and, with short interruptions, terminated in June, 1845, thus furnishing a five years' series of magnetic observations, taken bi-hourly up to October, 1843, and after that date hourly. The readings of each magnetic

[1] See "Observations at the magnetic and meteorological observatory at the Girard College, Philadelphia, made under the direction of A. D. Bache, LL D., and with funds supplied by the members of the American Philosophical Society and by the Topographical Bureau of the United States, 1840 to 1845. Printed by order of the Senate of the United States, and under the direction of the Topographical Bureau, second session of the twenty-ninth Congress, Washington, D. C., 1847."

Three volumes record and one volume plates.

element were united into mean values, arranged according to hours of the day and days of the month and annual values, and presented graphically, under my direction, by Joseph .S Ruth, esq., who had taken part in the observations, and who was at that time employed in the Coast Survey. As, owing to other laborious duties, the record could not then be submitted to a complete reduction and discussion, I have resumed the subject, with the aid of Charles A. Schott, esq., assistant in the Coast Survey, by whom, under my immediate direction, the discussions contained in this paper have been made and prepared for publication. It is proper to state that this work has been performed out of office hours by Mr. Schott, as my assistant in this special matter, and at my own expense.

Although the magnetic observations furnished by their judicious geographical location, a basis for the generalization of their results, it is, nevertheless, desirable to combine other results with them as confirmations or as corrections. In the investigation of the disturbance law at Point Barrow, as compared with the same at Toronto, a very remarkable mutual relation was developed, and further examination may bring to light other dependencies of a mutual character.

According to the latest determination, the position of the Girard College observatory is in latitude 39° 58′ 23″, (north,) and in longitude 75° 10′ 05″=5*h.* 00*m.* 40*s.* 3 west of Greenwich.[1] From Philadelphia, Toronto bears 38° 45′ west of north, (true,) and is distant 40° 50′ in arc, or about 334 statute miles.

It is proposed, in the present paper, to investigate the law of the eleven-year period, or, as it is more frequently called, the decennial period, there being yet an uncertainty as to its precise length. It is supposed to have some direct or indirect connection with the solar spot period, which, according to late investigations by Prof. R. Wolf,[2] is said to exhibit corresponding disturbances.

The discussion is a contribution towards the determination of the epoch of the occurrence of a minimum (as to number and magnitude) in certain phases of the magnetic variations and disturbances, corresponding to a minimum in the solar spot period. The method of reduction is substantially the same as that adopted by General Sabine, and explained in his discussion of the Toronto and Hobarton[3] observations.

Investigation of the eleven year period in the change of the amplitude of the solar-diurnal variation of the magnetic declination, comprising the regular as well as the disturbed diurnal variation.

While the magnitude of the deflection is the only criterion for the recognition of a disturbance, the adoption of any limit of deviation from the normal value for the same hour, month, and year, must necessarily remain in some measure arbitrary, or, in other words, there must always remain, after the separation of the disturbances, a certain small amount of their effect in the remaining regular diurnal progression. General Sabine has shown that the results are

[1] This longitude depends on that of Cambridge observatory, for which 4*h.* 44*m.* 30*s.*25 has been adopted.

[2] Astronomische Nachrichten, No. 1091, (May, 1857.)

[3] See three papers, by General Sabine, on periodical laws discoverable in the mean effects of the larger magnetic disturbances. Philosophical Transactions of the Royal Society, 1851, 1852, and 1856.

not sensibly affected by a small variation in the line of separation of the disturbed from the undisturbed readings.[1]

To effect the separation, I made use of Peirce's criterion[2] for the rejection of doubtful observations, applying it, however, to observations following a law different from the regular one.[3] From an examination of 465 hourly observations, distributed over different hours of the day and different months of the year, the following was the limit of separation:

$9^d.3$ from six months in 1840; 8.1 from six months in 1843; 6.0 from six months in 1845.

The mean of 7.8 divisions, equal to $3'.6$ of arc, has been adopted provisionally. Accordingly, all numbers in the printed record of observations, differing 7.8 scale divisions (or 10.3 divisions for June, and up to July 18, 1840,) for the mean monthly value of each hour of observation, were marked in pencil. It was found that the ratio of the disturbed observations to the total number was 1: 9.6, or for the years 1843, 1844, 1845, 1: 13.3 nearly, (the years 1843 and 1845 being incomplete, and omissions only approximately allowed for.) For comparison with the Toronto observations we have the ratio 1: 9.4 for the series 1841 to 1848 inclusive,[4] and 1: 13.6 for the series 1843, 1844, 1845,[5] both for the limit $3'.6$, which was afterwards raised to $5'.0$[6]. It was thought desirable in comparing these results, and especially as the Girard College observations do not extend either way to years of maximum of disturbance, which would otherwise require the enlargement of the limit to preserve the limit as pointed out by the criterion; hence a deviation from the normal of 8.0 scale divisions as a convenient number, $3'.64$ of arc, has been adopted for the present discussion as constituting a disturbed observation. Previous to July 18, 1840, the declinometer had a different scale, one division being $20''.7$, making the corresponding limit for the first month and a half 10.6 divisions.

All observations, therefore, differing 8.0 scale divisions from the mean monthly value of their respective hour were marked by a pencil line; a new hourly mean was taken, omitting values so marked, and each observation was again examined with reference to its deviation from this new mean. The process was repeated, when necessary, so that in all cases values differing $8^d.0$ or more from the final mean were excluded. The last mean thus obtained for each observing hour and each month has been called "the normal." The following tables of normals present the mean monthly declinometer readings for each observing hour, free from all disturbances, deviating either way $3'.64$ or more from the normal position of the magnet for the respective hour, month, and year. The observations having been made at the even Göttingen hours, the local times are $19\frac{1}{2}$ minutes after the even hour.[7] The time given in the tables is mean local time, counting from midnight, or $0h.$ up to $24h.$

Increase in the scale readings corresponds to a decrease of westerly declination. The value of one division of the scale is $0'.453$.

[1] In the first discussion of the Toronto observations for the years 1843, 1844, 1845, the limit of $3'.6$ was adopted, corresponding to one disturbance in every 13.6 observations; in the second discussion $5'.0$ was substituted as preferable. Phil. Trans. 1856, art. XV.

[2] Gould's Astronomical Journal, Vol. IV, No. 83, 1855.

[3] A similar application was made in the discussion of Dr. E. K. Kane's magnetic observations at Van Rensselaer harbor, North Greenland, by Mr. Schott. Smithsonian Contributions to Knowledge, vol. X, 1858.

[4] Observations made at the Magnetical and Meteorological Observatory at Toronto, in Canada, under the superintendence of Colonel Edward Sabine, vol. II, 1843, 1844, 1845, with abstracts of observations to 1852, inclusive. London, 1853.

[5] Phil. Trans., R. S., 1851, art V.

[6] Observations made at the Magnetical and Meteorological Observatory at Toronto, in Canada, under the superintendence of Major General Edward Sabine, vol. III, 1846, 1847, 1848, with abstracts of observations to 1855, inclusive. London, 1857.

[7] The observations were made at the even Gottingen time, $6h.\ 00m.$, corresponding to $0h.\ 19\frac{1}{2}m.$, of Philadelphia time.

TABLE I.

Normals of the declinometer readings for each observing hour and month in the year 1840.

[Observations taken 19¼ minutes after the hour indicated.]

MONTHS.	PHILADELPHIA MEAN TIME.											
	0*h*.	2*h*.	4*h*.	6*h*.	8*h*.	10*h*.	Noon.	14*h*.	16*h*.	18*h*.	20*h*.	22*h*.
	°	°	°	°	°	°	°	°	°	°	°	°
June*	494.4	495.0	497.5	504.0	502.7	493.8	485.5	483.4	487.9	492.8	492.5	493.6
July	497.3	497.2	498.9	504.7	505.5	495.4	484.5	484.0	488.7	493.3	495.5	496.3
August	495.3	495.7	498.8	506.4	509.1	489.4	480.5	481.9	488.2	493.2	494.9	496.1
September†	492.5	495.2	496.9	503.2	502.5	490.8	477.3	479.5	488.4	489.9	493.3	492.6
October	492.5	490.4	491.1	489.1	489.2	484.1	478.4	477.3	481.9	486.3	485.9	493.1
November‡	481.1	480.6	482.9	483.7	486.4	481.7	474.2	472.5	477.5	480.8	483.6	482.7
December	477.9	475.2	479.8	479.5	480.5	480.6	470.7	471.6	472.7	478.5	479.0	481.2
Mean	490.14	489.90	492.27	495.80	496.56	487.86	478.73	478.60	483.61	487.83	489.24	490.80
Correction§	+ 5.21	5.10	5.33	4.68	5.17	5.85	5.05	4.65	4.46	4.36	4.75	5.25
Mean for 1840	495.35	495.00	497.60	500.48	501.73	493.71	483.78	483.25	488.07	492.19	493.99	496.05
Correction for index‖	+ 93.30	......	......	......	......	......	......	......	......	......	......	......
Corrected mean for 1840	588.65	588.30	590.90	593.78	595.03	587.01	577.08	576.55	581.37	585.49	587.29	589.35

* The readings from June 1 to July 18, (15 hours,) on the college building scale, were converted into observatory scale readings by subtracting 144°.7 at division 628.8 of the old scale, and converting the value of a division 0′.345 of the old into the corresponding reading for the value of a division 0′.453 of the new scale. The mean readings, thus corrected, of the first 18 days of July, were then properly combined with the mean of the remaining days of the month.

† In the month of September, hour 8, the comparisons were made with the half-monthly means, owing to the rapid change of the readings.

‡ On the 23d of November the index of the declinometer bar shifted 19.5 scale divisions. A correction of + 19°.5 has therefore been added to observations after this date, and likewise to all the readings of the following month.

§ The corrections here given for referring the mean of the last seven months of the year to the mean for the whole year are derived from the normals of the following year 1841, by comparing the mean of the same seven months with the annual mean of that year. Comparing the same months in the two years, the character of the changes appears to be about the same.

‖ A further correction for change in the zero of the scale required to refer the readings of 1840 to the readings of subsequent years. Owing to a rearrangement of the instruments on January 7, 1841, the scale readings changed 112.8 divisions; and since 19.5 scale divisions had been added to the December readings, the resulting correction is the difference of the two, or + 93°.30.

TABLE II.

Normals of the declinometer readings for 1841.

[Value of 1 div. = 0′.453. Time, 19¼ minutes later than indicated.]

MONTHS.	PHILADELPHIA MEAN TIME.											
	0*h*.	2*h*.	4*h*.	6*h*.	8*h*.	10*h*.	Noon.	14*h*.	16*h*.	18*h*.	20*h*.	22*h*.
	°	°	°	°	°	°	°	°	°	°	°	°
January	579.3	577.0	578.6	576.9	580.7	581.9	570.0	568.8	570.3	574.2	578.0	580.1
February	575.0	573.2	575.6	577.8	582.1	579.5	569.5	566.0	569.5	572.4	574.4	575.8
March	577.1	577.6	580.9	582.9	586.8	578.9	569.4	567.7	571.8	576.4	577.4	577.7
April	580.0	581.9	582.9	585.6	587.6	579.4	568.8	566.1	571.7	576.9	578.0	579.1
May	579.1	579.8	581.9	587.4	589.1	578.6	569.4	567.9	573.6	577.4	578.5	580.1
June	571.7	572.2	574.7	583.3	582.6	571.1	561.6	560.3	565.0	570.1	570.9	570.8
July	569.9	568.5	571.6	578.4	581.2	571.8	558.9	557.3	562.3	567.2	568.8	568.6
August	568.4	570.3	571.6	580.1	583.9	568.9	558.3	556.9	564.0	566.8	568.6	568.9
September	565.1	564.5	565.5	569.4	571.1	564.1	553.6	554.5	559.5	562.9	563.8	564.0
October	566.8	566.3	565.5	567.6	569.4	568.2	564.0	562.3	564.7	573.5	568.6	569.3
November	557.2	558.5	558.5	557.6	561.7	557.1	551.8	549.9	553.4	554.9	558.0	558.6
December	560.1	559.3	560.5	559.6	560.1	558.1	552.9	551.7	555.8	559.6	563.3	561.6
Mean	570.81	570.76	572.32	575.55	578.03	571.47	562.35	560.78	565.13	569.36	570.70	571.22

In general during the year 1841, the readings are more changeable than during the following years.

The re-arrangement of the instruments, and consequent shifting of the index of the scale, alluded to in the preceding notes, interrupted the observations between January 1 and January 12.

The normal for October, 14*h*, was obtained by comparing with the half monthly means and taking the mean of the two results as in a similar case for the month of September of the previous year.

TABLE III.

Normals of the declinometer readings for 1842.

[Value of 1 div. = 0′.453. Time, 19¼ minutes later than indicated.]

MONTHS.	PHILADELPHIA MEAN TIME.											
	0*h*.	2*h*.	4*h*.	6*h*.	8*h*.	10*h*.	Noon.	14*h*.	16*h*.	18*h*.	20*h*.	22*h*.
	°	°	°	°	°	°	°	°	°	°	°	°
January	564.3	563.8	565.3	565.9	570.9	566.4	556.7	556.0	562.9	563.2	566.1	567.8
February	564.5	564.3	563.8	565.2	567.8	565.5	558.2	559.9	558.0	561.9	565.3	565.5
March	564.8	564.1	565.4	566.1	571.8	565.9	555.6	553.9	556.4	560.3	564.5	564 9
April	563.3	565.4	566 1	568.5	569.7	563.6	554.0	552.5	555.1	560.6	561.3	563 0
May	563.3	564.3	566.0	571.2	569.5	560.0	552.6	552.3	557.7	560.8	561.8	562.3
June	564.6	563.7	567.2	573.7	573.0	565.2	555.1	552.5	558.3	561.8	563.7	564.1
July	566.0	566.0	568.4	576.6	576.4	565.8	556.3	553.8	558.5	562.4	564.2	567.1
August	564.8	566.0	568.5	573.7	575.0	560.0	552.3	553.7	561.5	562.2	564.1	564.5
September	567.4	567.8	570.0	576.8	574.9	561.2	556.0	555.4	562.0	565.7	566.7	566.6
October	563.1	563.1	564.4	566.0	568.8	564.0	556.0	555.0	558.2	564.3	565.0	565.3
November	564.2	563.8	565.6	566.9	569.2	563.3	556.6	557.3	561.2	564.0	565.5	565.0
December	561.7	560.7	562.1	562.7	565.5	564.2	556.6	556.2	560.1	562.0	563.5	563.8
Mean	564.33	564.42	566.07	569.44	571.04	563.76	555.50	554.54	559.16	562.42	564.31	564.99

TABLE IV.

Normals of the declinometer readings for 1843.

[Value of 1 div. = 0′.453. Time, 19¼ minutes later than indicated.]

MONTHS.	PHILADELPHIA MEAN TIME.											
	0*h*.	2*h*.	4*h*.	6*h*.	8*h*.	10*h*.	Noon.	14*h*.	16*h*.	18*h*.	20*h*.	22*h*.
	°	°	°	°	°	°	°	°	°	°	°	°
January	......	......	......	......	......	......	......	555.4	......	......	......	......
February	......	......	......	......	......	......	....	555.9	......	......	......	......
March	......	......	......	....	......	......	......	557.2	......	......	......	......
April	569.7	570.0	571.0	574.7	576.2	566.2	557.8	555.7	562.6	564.8	568.5	568.7
May	567.0	567.3	569.6	574.6	575.6	565.7	556.0	556.2	562.2	566.4	566.9	567.3
June	566.0	565.6	568.4	574.1	573.9	564.8	556.4	556.0	561.1	564.3	564.0	565.6
July	566.9	565.9	568.2	574.2	574.6	564.5	555.1	554.1	559.5	563.6	563.8	565.6
August*	564.2	564.5	567.2	573.5	572.7	560.5	555.1	554.6	561.2	563.6	562.3	564.2
September	560.4	560.4	560.3	565.7	566.6	554.6	547.5	550.5	556 8	558.0	560.0	558.7
October	559.6	559.6	559.9	562.1	566.0	560.8	553.6	552.7	556.2	558.2	560.1	559.7
November	556.3	556.6	557.4	559.1	561.3	556.2	550.4	551.1	553.8	556.3	557.5	557.3
December	559.0	557.4	557.8	560.0	561.2	559 9	552.9	550.9	554.6	558.2	559.6	559.9
Mean	563.23	563.03	564.42	568.67	569 79	561.47	553.42	554.19	558.67	561.50	562.52	563.00
Correction†	+0.06	−0.11	−0.41	−1.24	−0.30	+0.63	+0.44	....	−0.02	−0.23	+0.33	+0.35
Corrected mean	563.29	562.92	564.01	567.43	569.49	562.10	553.86	554.19	558.65	561.27	562.85	563.35

* The suspension threads of the declinometer gave way on the 9th of August, and again on the 10th of January, 1844; but, after re-adjusting the instrument, the magnet returned almost exactly to its former reading—a mean of the two changes gave as a correction, + 18.7 divisions, which was accordingly added to all the readings of the year after August 9, 21 hours.

† The correction to refer the mean of the last nine months to the mean of all the months is derived from the readings of the preceding year, as being more uniform in character than those for the year following.

The hourly readings commence on October 1, and are continued to the close of the series.

To make the readings of the odd hours of the months of October, November, and December comparable with those of the even hours during the whole year, the means of the even hours for the months of October, November, and December (1843) were compared with the corrected annual means respectively, which gave the corrections for the even hours; and the corrections for intermediate odd hours were obtained from those of the nearest even hours. The deductions from the series of observations at odd hours have but one-third of the weight of those obtained from the even series.

TABLE IV, (b.)

Additional normals for the odd hours of the months of October, November, and December, 1843.

[Value of 1 div. = 0'.453. Time, 19¼ minutes later than indicated.]

MONTHS.	PHILADELPHIA MEAN TIME.											
	1*h*.	3*h*.	5*h*.	7*h*.	9*h*.	11*h*.	13*h*.	15*h*.	17*h*.	19*h*.	21*h*.	23*h*.
	°	°	°	°	°	°	°	°	°	°	°	°
October	560.2	559.1	560.6	565.1	565.0	556.5	552.6	554.2	557.0	559.7	561.1	560.7
November	556.7	556.6	557.4	561.8	560.1	552.6	550.0	552.6	554.9	557.5	557.7	557.4
December	558.1	558.2	558.8	560.8	561.9	556.7	551.4	553.1	557.5	558.9	560.0	559.5
Mean	558.33	557.97	558.93	562.57	562.33	555.27	551.33	553.30	556.47	558.70	559.60	559.20
Correction	+5.01	+5.37	+6.36	+6.84	+4.92	+2.37	+2.09	+3.20	+3.74	+3.74	+4.08	+4.70
Corrected mean	563.34	563.34	565.29	569.41	567.25	557.64	553.42	556.50	560.21	562.44	563.68	563.90

TABLE V.

Normals of the declinometer readings for 1844.

[Value of 1 div. = 0'.453. Time 19¼ minutes later than indicated.]

MONTHS.	PHILADELPHIA MEAN TIME.											
	0*h*.	1*h*.	2*h*.	3*h*.	4*h*.	5*h*.	6*h*.	7*h*.	8*h*.	9*h*.	10*h*.	11*h*.
	°	°	°	°	°	°	°	°	°	°	°	°
January	558.6	558.2	558.4	559.2	558.9	558.8	559.7	561.2	562.9	563.3	559.1	555.9
February	559.1	558 5	559.1	559.2	559.9	561.1	560.8	562.1	562.2	560.7	557.3	554.5
March	558.0	559.0	559.2	557.9	559.8	560.2	561.3	563.6	564.8	564 1	560.3	554.9
April	556.6	557.0	557.2	556.9	557.5	558.4	561.7	558.5	564.4	561.8	557.1	552.0
May	548.4	548.7	547.8	547.0	549.3	552.5	555.8	556.8	555.1	552.3	546.7	542.2
June	548.7	549.0	549.3	549.1	551.6	553.9	557.6	559.1	558.2	554.3	547.9	541.8
July	549.0	550.5	548.4	549.4	551.0	554.3	556.9	559.8	558.6	554.8	548.0	540.8
August	548.6	547.8	547.3	547.4	550.9	552.4	557.5	560.3	558.2	551.8	543.3	536.4
September	543.3	543.1	544.1	546.0	546.5	547.1	550.0	552.9	552.4	545.8	538.3	532.5
October	545.1	545.3	544.2	546.1	545.8	544.4	548.6	550.9	551.5	548.7	545.3	540.8
November	546.8	546.8	548.3	548.6	547.4	548.5	551.5	549.2	548.4	547.9	546.2	542.8
December	536.1	535.8	535.4	535.9	536.8	537.3	537.2	536.8	537.9	539.3	536.1	532.9
Mean	549.86	549.98	549.89	550.23	551.28	552.41	554.88	555.93	556.22	553.73	548.80	543.96

TABLE V—Continued.

MONTHS.	PHILADELPHIA MEAN TIME.											
	Noon.	13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.
	°	°	°	°	°	°	°	°	°	°	°	°
January	552.9	552.4	553.2	554.1	556.3	556.9	557.8	559.2	559.5	560.9	560.8	559.6
February	551.1	551 1	553 0	554.7	556 4	556.6	557.6	558.4	559.9	559.4	560.1	559.0
March	550.6	549.4	549.6	551.7	553.0	555.2	556.6	558.0	558.4	558.2	558.6	559.7
April	547.4	545.7	546.2	547.6	549.6	553.4	553.4	553.8	556.2	555.1	555.7	559.3
May	538.3	535.8	536.5	538.9	542.1	545.1	545.2	546.5	546.3	547.3	547.3	547.8
June	537.4	535.0	537.3	540.0	542.4	545.2	545.6	546.2	546.5	546.8	548.0	548.5
July	538.3	535.5	536.3	538.8	541.9	544.5	545.8	546.2	546.6	547.4	548.8	549.3
August	531.8	532.0	534.3	538.7	542.1	544.3	546.0	546.5	546.7	546.6	547.8	547.7
September	529.3	530.0	534.1	538.3	539.4	541.9	542.4	541.9	543.0	544.6	543.7	543.3
October	541.1	539.5	541.4	544.0	545.7	545.4	545.6	545.0	544.9	544.6	544.5	544.6
November	542.8	541.7	544.5	546.1	545.6	547.9	548.8	548.2	548.3	549.6	548.0	548 0
December	530.6	529.3	529.4	532.1	533.2	534.8	535.9	537.0	536.8	537.4	537.8	537.1
Mean	540.97	539.78	541.32	543.75	545.64	547.61	548.41	548.91	549.43	549.83	550.10	550.33

To the observations between January 1 and January 10 a correction of + 18°.7 was applied, as explained in the preceding note.

In the month of December the declination changed so rapidly as to require the use of half monthly means; the mean of the two results is inserted in the above table.

TABLE VI.

Normals of the declinometer readings for 1845.

[Value of 1 div. = 0'.453. Time $19\frac{1}{4}$ minutes later than indicated.]

MONTHS.	PHILADELPHIA MEAN TIME.											
	0h.	1h.	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.
	°	°	°	°	°	°	°	°	°	°	°	°
January	530.9	531.3	531.1	531.5	533.0	531.6	532.9	535.2	535.8	533.8	530.2	526.7
February	531.6	531.1	531.0	532.4	532.3	533.1	534.7	535.9	535.7	535.4	533.0	528.6
March	532.9	532.7	533.7	533.6	535.0	533.9	536.0	538.8	539.4	538.6	534.5	529.4
April	529.1	528.8	529.0	529.2	529.8	531.7	534.0	535.6	537.5	535 4	528.5	522.5
May	529.9	531.3	529.7	531.7	533.2	536.3	539.3	541.9	540.7	536 0	528.0	522.6
June	531.5	531.7	531.6	532.0	534 8	537.9	541.9	543.5	542.5	538.6	532.2	524.9
Mean	530.98	531.15	531.02	531.73	533.02	534.08	536.47	538 48	538.60	536.30	531.07	525.78
Correction*	−2.42	−2.50	−2.58	−2 41	−2 26	−2.03	−1.81	−2.01	−2.21	−2.76	−3.30	−2.94
Corrected mean	528.56	528.65	528.44	529.32	530.76	532.05	534.66	536.47	536.39	533.54	527.77	522.84

TABLE VI—Continued.

MONTHS.	PHILADELPHIA MEAN TIME.											
	Noon.	13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.
	°	°	°	°	°	°	°	°	°	°	°	°
January	524.2	525.2	526.2	528.0	530.1	531.8	532.7	532.8	533.3	533.0	532.4	532.0
February	524.4	523.0	525.3	527.5	529.7	530.4	532.4	531.3	533.6	534.4	532.3	531.9
March	524.8	522.5	522 8	524.8	527.8	529.7	531.6	533.0	533.0	533.8	533 5	534.0
April	517.8	513.9	514.0	517.2	521.5	525.8	527.8	527.9	528.1	528.5	528.0	529.4
May	517.1	516.8	518.9	522.1	526.7	529.3	529.6	530.4	529.7	530.3	530.5	530.3
June	521.3	519.6	520.0	522.1	525.4	528 9	530.3	530.7	530.1	530.7	530.3	531.4
Mean	521.60	520.17	521.20	523.62	526.87	529.32	530.73	531.02	531.30	531.78	531.17	631.50
Correction*	−2.59	−2 28	−1.98	−1.80	−1.62	−1.64	−1.65	−1.99	−2.23	−2.36	−2.47	−2.44
Corrected mean	519.01	517.89	519.22	521.82	525.25	527.68	529.08	529.03	529.07	529.42	528.70	529.06

* As indicated by the annual change in the readings, it was considered preferable to obtain the annual mean by deducing the correction to the mean of the first six months from the readings of the preceding year and those of the year 1842.

For the purpose of comparing the annual means of the normals, or the mean march of the regular solar-diurnal variation for each year, the preceding results have been expressed analytically by means of Bessel's formula, and by the application of the method of least squares.

In these formulæ the angle Θ is reckoned from midnight, (Philadelphia,) at the rate of 15° for each following hour. It was found unnecessary to carry the expressions beyond the third term, the fourth being generally smaller than the probable error of an hourly normal. We obtain accordingly—

For 1840...... $D = 586^\circ.73 + 6^\circ.214 \sin. (\theta + 36^\circ\, 35') + 4^\circ.588 \sin. (2\,\theta + 217^\circ\, 33') + 1^\circ.640 \sin. (3\,\theta + 68^\circ\, 50'.)$
1841...... $D = 569^\circ.87 + 4^\circ.888 \sin. (\theta + 30^\circ\, 05') + 4^\circ.380 \sin. (2\,\theta + 212^\circ\, 38') + 1^\circ.581 \sin. (3\,\theta + 50^\circ\, 14'.)$
1842 ..... $D = 563^\circ.33 + 4^\circ.944 \sin. (\theta + 33^\circ\, 49') + 4^\circ.211 \sin. (2\,\theta + 217^\circ\, 12') + 1^\circ.463 \sin. (3\,\theta + 64^\circ\, 42'.)$
1843...... $D = 562^\circ.01 + 4^\circ.449 \sin. (\theta + 36^\circ\, 00') + 3^\circ.918 \sin. (2\,\theta + 218^\circ\, 05') + 1^\circ.811 \sin. (3\,\theta + 68^\circ\, 18'.)$
1844...... $D = 548^\circ.89 + 4^\circ\,486 \sin (\theta + 34^\circ\, 35') + 3^\circ.872 \sin. (2\,\theta + 222^\circ\, 23') + 1^\circ.802 \sin. (3\,\theta + 68^\circ\, 53'.)$
1845...... $D = 528^\circ.12 + 4^\circ.548 \sin. (\theta + 35^\circ\, 33') + 4^\circ.872 \sin. (2\,\theta + 225^\circ\, 35') + 1^\circ.987 \sin (4\,\theta + 61^\circ\, 20'.)$

Owing probably to the several accidental changes in the suspension of the bar, and consequent uncertainty in the precise amount of scale correction, the mean readings of each year, when compared with one another, exhibit differences not actually due to inequalities occasioned by declination changes. This question, however, does not directly bear upon the present investigation, which mainly depends on differences of readings; and it is proper to remark that the observed increase, giving the weight one-half to the mean of 1840 and of 1845, is under the supposition of a uniform annual change between these years equal to 4′.50. From Mr. Schott's investigation* of the secular change of the declination at Philadelphia, supported by observations between the years 1701 and 1855, the annual increase between the years 1840 and 1845 is 4′.98, a result which accords tolerably well with actual observations. According to his formula, the declination on the first of January, 1843, the mean epoch of the present series was 3° 32′ west, with a probable error of $\pm$ 10′, which corresponds to the scale reading 560.31, deduced by taking into account the weights of the annual means.

We now proceed to the investigation of the inequality in the diurnal variation, changing the preceding formula, for greater convenience, into the following:

For 1840....... $\Delta = + 2'.815 \sin. (15^\circ\, n + 36^\circ\, 35') + 2'.078 \sin. (30^\circ\, n + 217^\circ\, 33') + 0'.743 \sin. (45^\circ\, n + 68^\circ\, 50'.)$
1841....... $\Delta = + 2'.214 \sin. (15^\circ\, n + 30^\circ\, 05') + 1'.984 \sin (30^\circ\, n + 212^\circ\, 38') + 0'.716 \sin. (45^\circ\, n + 50^\circ\, 14'.)$
1842....... $\Delta = + 2'.240 \sin. (15^\circ\, n + 33^\circ\, 49') + 1'.908 \sin. (30^\circ\, n + 217^\circ\, 12') + 0'.663 \sin (45^\circ\, n + 64^\circ\, 42'.)$
1843....... $\Delta = + 2'.015 \sin. (15^\circ\, n + 36^\circ\, 00') + 1'.775 \sin. (30^\circ\, n + 218^\circ\, 05') + 0'.820 \sin. (45^\circ\, n + 68^\circ\, 18'.)$
1844....... $\Delta = + 2'.032 \sin. (15^\circ\, n + 34^\circ\, 35') + 1'.754 \sin. (30^\circ\, n + 222^\circ\, 23') + 0'.816 \sin. (45^\circ\, n + 68^\circ\, 53'.)$
1845....... $\Delta = + 2'.060 \sin. (15^\circ\, n + 35^\circ\, 33') + 2'.206 \sin. (30^\circ\, n + 225^\circ\, 35') + 0'.900 \sin. (45^\circ\, n + 61^\circ\, 20'.)$

In which $\Delta =$ the regular solar diurnal variation, and n the number of hours after midnight.

To show the agreement between these expressions and the corresponding observed quantities, and to exhibit to the eye the character of the diurnal variation, the results have been thrown into curves. The observed bi-hourly means are represented in diagram 2, Sketch 37, by dots, and in no instance do they differ from the computed values by as much as 0°.8 or 0′.3. As a specimen of the representation, I add the results for the year 1845:

* Report on the progress of the U. S. Coast Survey for 1855, Appendix No 48 and Appendix No. 24 of the report for 1859.

Hour.	Observed value.	Computed value.	C—O.	Hour.	Observed value.	Computed value.	C—O.
h. m.	°	°	°	h. m.	°	°	°
0 19½	528.56	528.99	+0.43	12 19½	519.01	519.23	+0.22
2 19½	528.44	528.48	+0.04	14 19½	519.22	518.96	—0.26
4 19½	530.76	530.26	—0.50	16 19½	525.25	525.18	—0.07
6 19½	534.66	535.11	+0.45	18 19½	529.08	529.15	+0.07
8 19½	536.39	535.97	—0.42	20 19½	529.07	529.07	0.00
10 19½	527.77	528.18	+0.41	22 19½	528.70	528.86	+0.16

The average probable error of any single representation by the formula is $\pm$ 0°.22, or $\pm$ 0′.10.

By means of the preceding formulæ the following values were computed: 1. The time when the north end of the magnet reached its extreme eastern position, or, in other words, the epoch of the eastern elongation. 2. The corresponding maximum scale reading, or, more properly, the corresponding minimum of western declination. 3. The time of the occurrence of the western elongation; and, 4. The corresponding maximum reading of western declination. In the last two columns the difference of the scale readings, or the amplitude of eastern and western elongation, is made out in scale divisions, and also in minutes of arc. The inequality of this amplitude next requires our attention.

For—	Epoch of eastern deflection.	Corresponding scale reading.	Epoch of western deflection	Corresponding scale reading.	Amplitude.	
	h. m.	°	h. m.	°	°	′
1840	7 26 a. m.	595.67	1 34 p. m.	575.71	19.96	9.08
1841	7 49	577.96	1 49	560.21	17.75	8.06
1842	7 36	571.24	1 37	553.96	17.28	7.83
1843	7 40	569.54	1 24	553.06	16.48	7.46
1844	7 32	556.50	1 18	539.99	16.51	7.51
1845	7 34	536.65	1 16	517.81	18.84	8.53
Mean	7 36 a. m. ± 3		1 30 p. m. ± 4			

The inequality constituting the ten or eleven year period is plainly exhibited in the last two columns of the above table, the progression in the numbers being quite regular. The year 1843 is clearly indicated as the year of the minimum range of the diurnal fluctuation, but whether the period is one nearer to ten or to eleven years cannot be decided from the Girard College observations, since they do not embrace a year of maximum amplitude. The epoch of the minimum, however, can be determined with more precision. For this purpose only, the values in the last column are represented by the formula,

$$A = 9'.08 - 1'.14\ (t - 1840.5) + 0'.201\ (t - 1840.5)^2,$$

deduced by the method of least squares, and the quantities come out as follows:

Year.	Observed amplitude.	Computed by formula.	Difference	Year.	Observed amplitude.	Computed by formula.	Difference.
1840.5	9'.08	9'.08	0'.00	1843.5	7'.46	7'.47	—0'.01
1841.5	8'.06	8'.14	—0'.08	1844.5	7'.51	7'.74	—0'.23
1842.5	7'83.	7'.60	+0'.23	1845.5	8'.53	8'.41	+0'.12

Probable error of any single amplitude, ± 0'.11.

That portion of the ten or eleven year period which results from the preceding discussion of the differential observations of the magnetic declination, free from the effect of the disturbances, as far as the latter can be eliminated, is shown graphically in diagram 1, Sketch No. 37.

The month of May, in the year 1843, is indicated by the formula as the epoch of the minimum amplitude.

We now proceed to the discussion of the disturbances as far as they bear on the decennial inequality, taking in also some collateral results.

The total number of observations for changes of declination recorded and discussed amounts to 24,566; of these, 2,357 were separated as disturbances differing eight scale divisions or more from their respective normals, leaving 22,209 observations, from which the preceding results were deduced. There is one disturbed observation in every 10.4 observations.

The discussion of the disturbances divides itself into two parts, that of the number and that of the amount of the larger deflections.

Owing to partial incompleteness in the number of observing months in some years, it became necessary to fill out the number for the annual inequality from the results of the complete years. Their number for each month in the complete years is given in the following table, the numbers for 1844 having first been divided by two, in order to make the hourly observations comparable with the bi-hourly in the years 1841 and 1842:

Month.	1841.	1842.	1844.	Mean.	Ratio.
January	33	44	5	27	0.75
February	25	26	5	19	0.53
March	26	24	24	25	0.70
April	25	31	39	32	0.89
May	33	14	17	21	0.58
June	31	30	7	23	0.64
July	30	40	15	28	0.78
August	49	64	44	52	1.45
September	57	60	31	49	1.36
October	94	86	53	78	2.17
November	81	22	42	48	1.33
December	55	5	26	29	0.82
Sum	539	446	308	431	12.00
Mean	....	....	....	36	1.00

The last column contains the ratio of the mean monthly value to the mean annual value. By means of these ratios, and using the observed monthly values in each defective year, the numbers in the following table were filled up, all the deduced values being indicated by brackets. As in the preceding table, the values refer or were made to refer to bi-hourly observations.

Table showing the number of disturbances in each month of the years 1840 *to* 1845.

Month.	1840.	1841.	1842.	1843.	1844.	1845.	Mean.	Ratio.
January	(30)	33	44	(17)	5	19	25	0.77
February	(21)	25	26	(12)	5	13	17	0.52
March	(28)	26	24	(16)	24	14	22	0.68
April	(36)	25	31	21	39	2[illegible]	29	0.91
May	(24)	33	14	15	17	11	19	0.58
June	8	31	30	12	7	12	17	0.53
July	44	30	40	20	15	(17)	28	0.86
August	40	49	64	80	14	(32)	51	1.59
September	56	57	60	27	31	(30)	44	1.36
October	94	94	86	16	53	(48)	68	2.12
November	19	81	22	8	42	(28)	35	1.08
December	83	55	5	4	26	(18)	32	1.00
Sum	344	539	446	230	308	91	387	12.00
Corrected sum and mean	483	----------	----------	275	----------	264	32	1.00

The ratios in the last column show the annual inequality in the distribution of the disturbances. The principal maximum occurs in October,* the secondary in April; the two minima, nearly of equal amount, occur in the months of February and June. The progression of the numbers is regular.

If we separate the numbers in accordance with westerly and easterly deflections we obtain the following table, deduced as in the former case. It may be remarked that on account of the separate ratios used for the interpolation of the western and eastern deflections, their sum in any one month does not give the corresponding number in the above table exactly, only the yearly sums having been preserved; and the same is true in regard to the table, showing the amount of the disturbances. Interpolated values, as before, are enclosed between brackets.

* At Toronto this maximum occurred in September; the first minimum is likewise one month earlier at this station than at Philadelphia.

Month.	1840.		1841.		1842.		1843.		1844.		1845.		Sums.		Ratios.	
	W.	E.	W.	E.	W.	E.	W.	E.	W.	E.	W.	E.	W.	E.	W.	E.
January	(36)	(2)	25	8	35	9	(22)	(7)	2	3	10	9	130	38	1.27	0.42
February	(17)	(3)	9	16	17	9	(13)	(9)	3	2	11	2	70	41	0.70	0.46
March	(23)	(5)	11	15	17	7	(15)	(6)	10	14	9	5	85	52	0.83	0.57
April	(27)	(5)	10	15	14	17	7	14	25	14	15	7	98	72	0.95	0.80
May	(17)	(4)	18	15	8	6	7	8	4	13	3	8	57	54	0 55	0.60
June	3	5	15	16	17	13	2	10	3	4	5	7	45	55	0.44	0.61
July	17	27	5	25	14	26	11	9	6	9	(7)	(11)	60	107	0.58	1.18
August	20	20	18	31	55	9	67	13	25	19	(20)	(11)	205	103	2.00	1.14
September	36	20	14	43	11	49	6	21	18	13	(11)	(21)	96	167	0.92	1.86
October	68	26	34	60	17	69	6	10	23	30	(15)	(30)	163	225	1 58	2.50
November	11	8	41	40	11	11	5	3	16	26	(15)	(14)	99	102	0.96	1.12
December	77	6	24	31	1	4	2	2	12	14	(8)	(10)	124	67	1.21	0.74
Sum	232	112	224	315	217	229	113	90	147	161	53	38	1232	1083	12.00	12.00
Corrected mean	352	131	......	......	....	....	163	112	....	....	129	135	....	....	....	....
Total	483		539		446		275		308		264		2315		....	

The ratios show a general correspondence in the number of westerly and easterly deflections; the westerly deflections seem to occur most frequently in August, while the easterly predominate in October; the secondary maximum of either series is in April. The minima remain nearly as before, one minimum of eastern deflection occurring in January.

With respect to the whole number of westerly and easterly deflections, we deduce the proportional sums from the following table:

Year.	W.	E.	Sum.	
1840	352	131	483	Weight ½.
1841	224	315	539	
1842	217	229	446	
1843	163	112	275	Weight ⅔.
1844	147	161	308	
1845	129	135	264	Weight ½.
Sum	1232	1083	2315	....
Proportional sums by weight.	937	912	....	....

On account of the incompleteness of the record in the years 1840, 1843, and 1845, the number of eastern and western disturbances relative to the total number cannot be ascertained with accuracy. They are about equal in the record. At Toronto the eastern predominate over the western in the proportion of 1. 17 to 1 (for the years 1841 to 1848,) and nearly to the same extent for each year, taken separately.

The numbers in the column headed "sum" do not indicate the law of the eleven year period as plainly and systematically as they did the investigation of the diurnal amplitude; yet giving half weight, on account of the want of record, to the sums for 1840 and 1845, the minimum number falls in the year 1843. More consistent results would, no doubt, have been obtained if the year 1845 had been complete.

If we distribute the disturbances (1,942 in number for the even hours) according to their respective hours of occurrence, the following table results from observations between 1840 and 1845:

Add 19½ m.	W.	E	Sum.	RATIOS. W.	RATIOS. E.	Add 19½ m.	W.	E.	Sum.	RATIOS. W.	RATIOS. .
Hours						*Hours.*					
0	67	95	162	0.82	1.20	Noon.	93	57	150	1.13	0.71
2	97	92	189°	1.18	1.16	14	79	54°	133°	0.95	0.67°
4	89	79	168	1.08	0.96	16	88	60	148	1.07	0.78
6	110°	63	173	1.35°	0.80	18	72	71	143	0.87	0.90
8	105	56	161	1.29	0.70	20	34°	133°	167	0.40°	1.66°
10	107	71	178	1.32	0.88	22	45	125	170	0.54	1.58

Maxima and minima values are distinguished by an asterisk.

The numbers in each vertical column show a regular progression; and the number of disturbances, irrespective of their direction. have a minimum at 2 p.m. and a maximum at 2 a.m.* The principal contrast is between the hours of the day and the hours of the night; in the former case the numbers being below, but in the latter above the mean value. This is in close correspondence with the Toronto results. The most striking result of the above table is, that the westerly disturbances have their minimum precisely at the hour (8 p.m.) when the easterly have their maximum value; and the exact coincidence of this result with that deduced by General Sabine for Toronto is not less remarkable. For the westerly disturbances, the hours 6 a.m., (maximum,) and 8 p.m., (minimum,) and for the easterly disturbances the hours 2 p.m., (minimum,) and 8 p.m., (maximum,) are specially contrasted. These results also agree with those found at Toronto; and the accordance with that station even goes so far as to exhibit the secondary minimum of eastern disturbances at 8 a.m. In connection with this subject it may be here stated that the same distinguished magnetist found a singular mutual relation to subsist between the phenomena at Toronto and Point Barrow, on the shores of the Arctic sea—the laws of the easterly deflection at one station being found to correspond for the same local hours with those of the westerly deflections at the other station, and *vice versa.* This contrast holds good for Philadelphia as well as for Toronto.

We now pass to the consideration of the amount of deflections caused by the disturbances, classifying the same according to years, months, and hours:

Aggregate values of the disturbances and mean values in the different years.

Year.	Aggregate values.	Same corrected to 12 months.	Number.	Average value of a disturbance.	Same in minutes of arc.	Same at Toronto for comparison.
	d.	*d.*		*d.*	′	′
1840	5140.0 (7 months.)	7155.5	483	14.8	6.70	
1841	7844.4	7844.4	539	14.6	6.61	6.34
1842	6019.1	6019.1	446	13.5	6.11	5.90
1843	2465.7 (9 months.)	2932.2	275	10.7	4.85	5.62
1844	4227.3	4227.3	308	13.7	6.21	6.49
1845	1138.6 (6 months.)	3521.4	264	13.3	6.02	5.84

° At Toronto the respective hours are 2 p. m. and 22 p. m.

The table includes only the series of bi-hourly observations, the reduction of the numbers from incomplete years to the correct sum for the whole year being effected by means of ratios, as in the discussion of the number of disturbances. For comparison the average value of a disturbance at Toronto is added. It must be remarked that the amount of deviation from the normal, constituting a disturbance, was nearly but not quite the same at Toronto as at Philadelphia, so that the ratios of the corresponding numbers in the last two columns should be compared.

The eleven year period is well marked in the aggregate value of the disturbances as well as in their average value in the different years; and the year 1843 is decidedly indicated as the minimum. To find a more precise value for the epoch of the minimum, the formula

$$\delta = 7'.09 - 0'.930\ (t - 1840.5) + 0'.149\ (t - 1840.5)$$

has been constructed, which represents the observed values as follows:

Year.	Observed amount.	Computed amount.	Difference.	Year.	Observed amount.	Computed amount.	Difference.
1840. 5	6'.70	7'.09	+0'.39	1843. 5	4'.85	5'.64	+0'.79
1841. 5	6'.61	6'.31	—0'.30	1844 5	6'.21	5'.75	—0'.46
1842. 5	6'.11	5'.83	—0'.28	1845. 5	6'.02	6'.16	+0'.14

The first and last value have only half weight. According to the formula, the minimum took place in August, 1843. (See diagram 3, sketch No. 37.)

As the resulting epoch from the differential observations with the declinometer, we find the month of June, 1843, by giving double weight to the result deduced from the inequality of the diurnal amplitude.

Separating into western and eastern disturbances, we find—

Year.	West deflections.			East deflections.		
	Aggregate value.	n.	Average value.	Aggregate value.	n.	Average value.
	d.		'	d.		'
1840	5064. 8	352	6. 52	2090. 7	131	7. 20
1841	2935. 5	224	5. 93	4908. 9	315	7. 07
1842	2645. 9	217	5. 53	3373. 2	229	6. 70
1843	1741. 6	163	4. 85	1190. 6	112	4. 85
1844	2019. 7	147	6. 21	2207. 6	161	6. 21
1845	1489. 2	129	5. 25	2032. 3	135	6. 84

From which it appears that the easterly values preponderate over the westerly in the ratio of 1.14 to 1. The ratio from the Toronto observations between 1844 and 1448 is 1.28 to 1.

The following table shows the aggregate amount of disturbances in each month of the different years, or the annual inequality of the aggregate disturbances.

Month.	1840.	1841.	1842.	1843.	1844.	1845.	Mean.	Ratio.
	d.	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	
January	(418.4)	423.6	585.9	(171.0)	45.3	269.2	318.9	0.72
February	(323.0)	402.3	310.1	(131.9)	99.7	160.1	237.8	0.54
March	(400.5)	327.9	264.4	(163.6)	430.0	167.4	292.3	0.66
April	(544.6)	294.7	481.1	281.7	601.5	289.7	415.6	0.94
May	(329.0)	442.8	184.4	206.8	205.5	111.0	246.6	0.56
June	83.1*	355.5	353.1	133.9	50.4	141.2	186.2	0.42
July	668.8*	416.8	546.8	271.5	168.3	(220.4)	382.1	0.87
August	618.6	823.1	873.5	953.9	552.6	(434.2)	709.3	1.61
September	853.5	1242.7	779.9	301.5	448.6	(484.1)	685.0	1.56
October	1319.1	1376.2	1253.2	195.0	668.1	(639.3)	908.5	2.06
November	314.6	1054.2	339.3	87.1	591.1	(387.4)	462.3	1.06
December	1282.3	684.6	47.4	34.3	366.2	(217.4)	438.7	1.00
Sum	7155.5	7844.4	6019.1	2932.2	4227.3	3521.4	5283.3	12.00

* The differences of the disturbed readings from their respective normals, during the month of June and part of July, 1840, were first converted from the old scale into equivalent new scale values.

The last column of ratios of the aggregate value of the disturbances of each month to the mean of all corresponds very closely to the analogous ratios deduced in a preceding table for the number of disturbances, giving the law in reference to the number and amount of disturbances in a year as the same, or nearly so. The maximum amount of disturbances occurs in October, (at Toronto in September,) the minimum amount in June, (the same at Toronto;) the secondary maximum occurs in April, (as at Toronto), and the secondary minimum in February, but at Toronto in January, from comparison with the years 1843, 1844, 1845.

The next tables give the aggregate monthly values in the six years, separated into west and east deflections:

West deflections.

Month.	1840.	1841.	1842.	1843.	1844.	1845.	Mean.	Ratio.
	d.	*d.*	*d.*	*d.*	*d.*	*d.*	*d.*	
January	(495.5)	308.4	444.8	(170.4)	23.8	161.6	267.4	1.21
February	(238.0)	147.2	217.1	(82.0)	28.0	69.9	130.4	0.59
March	(288.7)	127.2	168.5	(99 5)	172.8	117.5	162.4	0.73
April	(432.2)	97.9	216.9	98.9	370.1	171.0	229.5	1.04
May	(212.8)	229.5	84.4	109.7	43.5	8.3	114.7	0.52
June	30.9	170.4	194.2	21.7	12.6	65.9	82.6	0.37
July	186.7	51.1	140.5	153.3	28.9	(42.9)	100.6	0.46
August	275.9	228.4	721.3	609.7	304.5	(247.5)	431.2	1.95
September	495.3	257.8	116.7	65.2	249.3	(123.5)	217.9	0.99
October	1019.9	422.5	172.5	74.4	340.3	(185.5)	369.2	1.67
November	178.4	5[illegible]6.9	159.6	39.1	267.1	(196.9)	238.0	1.09
December	1210.5	308.2	9.4	17.7	178.8	(98.7)	303.9	1.38
Sum	5064.8	2935.5	2645.9	1741.6	2019.7	1489.2	2647.8	12.00

East deflections.

Months.	1840.	1841.	1842.	1843.	1844.	1845.	Mean.	Ratio.
	d.	d.	d.	d.	d.	d.	d.	
January	(27.9)	115.2	141.1	(22.7)	21.5	107.6	72.7	0.33
February	(55.7)	255.1	93.0	(38.5)	71.7	90.2	100.7	0.46
March	(81.8)	200.7	95.9	(53.4)	257.2	49.9	123.2	0.56
April	(116.7)	196.8	264.2	182.8	231.4	118.7	185.1	0.84
May	(66.2)	213.3	100.0	97.1	162.0	109.7	123.6	0.56
June	52.2	185.1	158.9	112.2	37.8	75.3	103.6	0.47
July	482.1	365.7	406.3	118.2	139.4	(177.5)	261.5	1.29
August	342.7	594.7	152.2	144.2	248.1	(194.8)	279.4	1.28
September	358.2	964.9	663.2	236.3	199.3	(358.3)	466.7	2.12
October	299.2	953.7	1080.7	120.6	327.8	(453.0)	539.2	2.46
November	136.2	467.3	179.7	48.0	324.0	(187.6)	223.8	1.02
December	71.8	376.4	38.0	16.6	187.4	(116.6)	134.4	0.61
Sum	2090.7	4908.9	3373.2	1190.6	2207.6	2032.2	2633.9	12.00

NOTE.—Maxima in September (mean of August and October) and April; minima in June and January, as at Toronto.

The following table gives the aggregate values of the disturbances distributed into the different hours of the day, as deduced from bi-hourly observations made from 1840 to 1845:

Philadelphia hour, (+19½ m.)	AGGREGATE VALUES OF WESTERN DEFLECTIONS, EASTERN DEFLECTIONS, AND SUM.			MEAN AGGREGATE VALUES FOR ONE YEAR.			RATIOS.		
	W.	E.	Sum.	W.	E.	Sum.	W.	E.	Both combined.
h.	d.	d.	d.	d.	d.	d.			
0	897.4	1438.5	2335.9	149.6	239.8	389.4	0.83	1.24	1.04
2	1259.7	1278.2	2537.9	209.9	213.0	422.9	1.16	1.10	1.13
4	1255.5	1075.5	2331.0	209.2	179.3	388.5	1.16	0.92	1.04
6	1581.7	773.6	2355.3	263.6	128.9	392.5	1.46	0.67	1.06
8	1512.4	769.9	2282.3	252.1	128.3	380.4	1.39	0.67	1.02
10	1315.2	901.9	2217.1	219.2	150.3	369.5	1.22	0.77	0.99
Noon	1114.8	733.2	1848.0	185.8	122.2	308.0	1.03	0.63	0.83
14	1056.4	735.0	1791.4	176.1	122.5	298.6	0.98	0.63	0.80
16	1068.1	825.8	1893.9	178.0	137.6	315.6	0.99	0.72	0.85
18	902.1	965.2	1867.3	150.3	160.9	311.2	0.84	0.89	0.84
20	408.9	2175.4	2584.3	68.2	362.6	430.8	0.38	1.88	1.15
22	610.4	2180.3	2790.7	101.7	363.4	465.1	0.56	1.88	1.25
Sum	12982.6	13852.5	26835.1	2163.7	2308.8	4472.5	12.00	12.00	12.00
Mean	....	....	....	180.3	192.4	372.7	....	....	....

If we compare these ratios with the corresponding numbers in the preceding tables showing the bi-hourly distribution in regard to the number of disturbances, we find, irrespective of the directions of the deflections, the 2 p. m. minimum preserved; the maximum occurs at 10 p. m. At Toronto, from a five years' hourly series, commencing with 1844, these hours are respectively 1 p. m. and 9 p. m. At Philadelphia, as at Toronto, the ratios are nearly invariable from 10 a. m. to 6 p. m., being then below unity; and again from 8 p. m. to 8 a. m., when they are above unity.

The easterly maximum and the westerly minimum at 8 p. m., appear again as a decided feature, and in general the respective ratios exhibiting the diurnal distribution of the disturbances, both in an easterly and westerly direction, show almost a perfect correspondence in regard to both number and amount.

The next table exhibits the excess of westerly disturbance over easterly (the sign — indicating a defect, or excess of easterly over westerly) in the aggregate values of the five-year series, and in the last column the mean effect of the same at each even hour is given as obtained by dividing the aggregate differential value of the preceding column by the actual number of days of observation during the whole period. The last column exhibits, therefore, the mean diurnal disturbance variation. The number of days is very nearly 1,500.

Philadelphia mean time.	Excess of westerly over easterly values.	Diurnal variation caused by the larger disturbances.		For comparison: Disturbance variation at Toronto, 1843–'44–'45, (at even hours.)	Philadelphia mean time.	Excess of westerly over easterly values.	Diurnal variation caused by the larger disturbances.		For comparison: Disturbance variation at Toronto, 1843–'44–'45, (at even hours.)
		In scale divisions.	In minutes of arc.				In scale divisions.	In minutes of arc.	
h. m.	*d.*	*d.*	′	′	*h. m.*	*d.*	*d.*	′	′
0 19¼	−541.1	−0.36	−0.16	−0.36	Noon. 19¼	+381.6	+0.25	+0.11	+0.09
2 19¼	− 18.5	−0.01	−0.01	−0.20	14.19¼	+321.4	+0.21	+0.10	+0 04
4 19¼	+180.0	+0.12	+0.05	−0.03	16.19¼	+242.3	+0 16	+0.07	+0.03
6 19¼	+806.1	+0.54	+0 24	+0.02	18.19¼	−63.1	−0 04	−0.02	−0.16
8 19¼	+742.5	+0.50	+0.22	+0.10	20.19¼	−1765.5	−1.18	−0.53	−0.56
10 19¼	+413.3	+0.28	+0.13	+0.06	22.19¼	−1569.9	−1.05	−0.47	−0.75

The law governing the disturbances during a solar day is clearly shown, and systematic in character. If we plot the disturbance curve on the same scale, or actually superpose it on the curves of the regular diurnal variation, (diagram 2, sketch No. 37,) the difference would hardly show to the eye. The diagram (No. 4) showing the disturbance variation has, therefore, been plotted on a larger scale.

The curve has but one maximum and one minimum; its most prominent feature is the easterly deflection at 8 o'clock (+ 19½ *m.*) p. m., (at Toronto it is at 9 p. m.) At that hour the maximum deflection amounts to 32″ of arc, and to 45″ at Toronto. The greatest westerly deflection occurs at 6*h.* (+ 19½*m.*) a. m., and amounts to but 14″; the Toronto hour is 8 a. m. with 6″, and from a five years' series of observation with 31″ of deflection.

The range of the disturbance variation equals 46″ *. The disturbance amplitude, as well as the regular variation amplitude, is greater at Toronto than at Philadelphia, the occurrence of the maximum and minimum disturbance deflection seeming to be about one hour earlier at the latter station. From three in the morning till five in the afternoon, the mean effect of the disturbances is to deflect the north end of the magnet to the west, and during the remaining hours (principally at night) to the east. The westerly and easterly disturbance deflections during a day balance within 0″.02.

The annual inequality in the amplitude of the diurnal disturbance variation might be satisfactorily shown by the proper combination of the results for consecutive years, comparing each two-year series successively; but owing to the small amount of the amplitude itself, and the incomplete or partly interrupted series of observations in the years 1840, 1843, and 1845, it was thought best to restrict the present discussion to the mean disturbance variation.

It is my intention to continue the discussion of the observations made at the Girard College observatory.

* At Toronto 51″, and from a five years' series 83″.

After the above was written, No. 1,185* of the Astronomische Nachrichten came to hand, containing Prof. R. Wolf's interesting results on the close connection of the variation in frequency of the solar spots, and the corresponding inequality in the amplitude of the diurnal variation of the declination. He deduces for Munich the formula $\beta = 6'.273 + 0'.051\ a$—in which a is a relative number, expressive of the frequency of the solar spots directly derived from observation, and the amplitude of the diurnal variation. He finds a very close correspondence between the computed and observed values of β, and gives in a table Dr. Lamont's and his own results between the years 1835 and 1850. He also reaffirms his former value for the average length of the solar spot period, viz, 11.11 years $\pm$ 0.04 years, the limits of variation being 8 and 16 years. This period is deduced from observations of maxima and minima since 1626.

For Philadelphia we have $\beta = 7'.080 + 0'.039\ a$, representing the observed amplitudes as follows:

Year.	a (from solar spot) observations.	β derived from a.	Observed amplitude, or β.	Difference observed and computed β.	Year.	a (from solar spot) observations.	β derived from a.	Observed amplitude, or β.	Difference observed and computed β.
1840	51.8	9'.10	9'.08	$-$0'.02	1843	8.4	7'.41	7'.46	$+$0'.05
1841	29.5	8'.23	8'.06	$-$0'.17	1844	12.2	7'.55	7'.51	$-$0'.04
1842	19.2	7'.83	7'.83	0'.00	1845	32.4	8'.34	8'.53	$+$0'.19

The correspondence between the observed diurnal amplitude and the same derived from observations of the solar spots is further exhibited by diagram 5, Sketch No. 37, the heavy line representing the magnetic, the other the solar, amplitude curve. The dotted curve is from the Toronto magnetic observations, merely multiplied by $\frac{8}{9}$ to reduce (approximately) to the Philadelphia scale. The next maximum amplitude, according to the solar spot observations, would be in 1848, amounting to 11'.00; and the whole range of the inequality in the amplitude of the diurnal motion would, therefore, be 11'.00—7'.46 = 3'.54. The last quantity. it must be observed, is slightly variable with each period; thus, according to the solar spot observations, the year 1837 was a maximum, amplitude 11'.41; and the year 1856 a minimum, amplitude 7'.24, the difference being 4'.17.

It is much to be desired that this interesting branch of physical inquiry should be further studied, as it forms one of the links connecting terrestrial with cosmical phenomena.

* For former communication by Prof. Wolf, see Nos 839, 1,013, 1,091, 1,132, 1,160, and 1,181, *ibid.*

APPENDIX No. 23.

Results reported from the observations made by Assistant Charles A. Schott, for magnetic declination, dip, and horizontal intensity, in Sections I *and* II, *and Canada,* 1859.

No.	Locality.	Date.	Latitude.	Longitude.	Declination West.	Dip North.	Horizontal intensity.	Total intensity.
		1859.	° ′	° ′	° ′	° ′		
1	Beacon Hill, Gloucester, Mass	July 8	42 36.4	70 38.4	12 03	74 45.6	3.645	13.86
2	Thompson, Cape Ann	9	42 36.7	70 43.5	11 09	74 30.4	3.674	13.75
3	Rockport, Cape Ann	11	42 39.6	70 36.3	11 37	75 05.9	3.529	13.72
4*	Annisquam, Cape Ann	11	42 39.4	70 40.3	....	74 56.1	3.589	13.81
5	Ipswich, Mass	12	42 40.8	70 49.8	11 14	74 37.3	3.598	13.57
6	Plum Island, Newburyport	13	42 48.0	70 48.5	10 58	74 52.9	3.528	13.53
7	Kittery Point, Portsmouth	14	43 04.8	70 42.7	11 15	75 04.2	3.496	13.57
8†	Bowdoin Hill, Portland	15	43 38.8	70 16.2	12 20	....	3 456	....
9	Quebec, Canada	18 & 19.	46 48.4	71 14.5	16 17	77 17.5	2.991	13.60
10‡	Montreal, Canada	20	45 30.5	73 34.9	....	76 51.4	3.111	13.68
11	Rutland, Vt	21	43 36	72 55	9 49	75 19.8	3.464	13.68
12	Deerfield, Mass	23	42 33	72 36	9 25	74 35.3	3.617	13.61
13	Chesterfield, Mass	25	42 24	72 51	8 54	74 21.2	3.667	13.60
14	Springfield, Mass	26	42 06	72 32	8 39	74 14.9	3.691	13.60
15§	Hartford, Conn	27	41 46	72 40	....	74 07.4	3.716	13.58
16‖	Coast Survey Office, Washington, D. C	29 & 30.	38 53.1	77 00.2	....	71 24.4	4.306 } 4.308 }	13.51

* Owing to a considerable disturbance at the time of occupation the result for declination has been rejected.

† The dip at Portland, 74° 56′.7, seems to be too small, probably owing to a disturbance at the time. The total intensity was left blank accordingly.

‡ The declination seems to have been affected by a considerable disturbance at the time, and the result, 12° 21′, had better not be used.

§ The declination seems to be affected by a disturbance, the value, 7° 17′, being too small.

‖ Occupied for intensity June 22 and 23, 1859, and July 30, 1859; for dip, June 23 and July 29. Mean date for dip and intensity, July 11.

APPENDIX No. 24.

Report of Assistant Charles A. Schott on the latest results of the discussion of the secular change of the magnetic declination, accompanied by tables showing the declination (variation of the needle) for every tenth year from the date of the earliest reliable observation, for twenty-six stations on the Atlantic, Gulf, and Pacific coasts of the United States.

COMPUTING DIVISION, COAST SURVEY OFFICE,
November 4, 1859.

DEAR SIR: In accordance with the Superintendent's letter of January 21, 1859, I have prepared a set of tables for practical use, giving the secular change of the magnetic declination, and showing for every tenth year, from the date of the earliest reliable observations to the present time, the magnetic declination (commonly called the variation of the magnetic needle) for stations on or near the northeastern coast of the United States, and also for some stations on our southern and western coasts—as derived from my several discussions of the secular change, in which have been included the latest data in possession of the Coast Survey. For the eastern and southern coasts the following papers may be referred to: Coast Survey Report for 1855, Appendix No. 48, pp. 306–337: Coast Survey Report for 1858, Appendix No. 25, pp. 192–195; and Appendix No. 26, pp. 195–197. For the western coast, Coast Survey Report for 1856, Appendix No. 31, pp. 228–235, may be consulted.

In general, the secular change of the declination appears to be of a periodic character, but

in no instance has a whole cycle been completed on either coast. Its length, therefore, remains necessarily in a great measure uncertain, and the tentative analytical process so far followed has for its main object the proper representation of all reliable observations made at any one station, so as to furnish the means of interpolation, and also to enable us to calculate the magnetic declination for any required place and date within the limits of the discussion. In the investigation of 1855 a linear function was used in the discussion, which does not involve the duration of the period, and on this account the results were, in regard to time, of rather limited extent.—(See remark on p. 337 of Report for 1855.)

For the Western Coast stations, I still prefer to retain this form of the discussion. Subsequently, by means of the knowledge gained in that discussion, an attempt was made to substitute a circular function, directly involving a period or periods, the length of which, as well as all other numerical co-efficients in the formula for the secular change, has been determined by applying the method of least squares. The use of a circular function—commenced in 1858 with two stations—is now extended to eighteen, within the limits stated above, and it has also been applied to some stations in Canada, the southern coast of the United States, and Central America, in order to furnish material for the generalization of the law, so far as ascertained, in reference to epochs and rate of change. A secondary period within the first was traced at several stations, its length, however, being much more variable and uncertain was found fluctuating between one-half and one-fifth of the primary period, while its amplitude was on the average fifteen times smaller than that of the primary wave for stations forming group 1, or within the geographical limits of Portland, Burlington, and Williamsburg. This smaller amplitude was found nearly constant, and equal to $0^{\circ}.4$.

To make the present paper more complete, it contains also the record of all observations used in the discussion not heretofore published in the Coast Survey reports.

As long as the cause producing the secular change remains altogether unknown, it is not safe to trust too far to the continuation of the law thus empirically derived; and in the following tables no value, deduced by the formula, has been inserted antecedent to the first observation by more than ten years. The tabular values may, therefore, be regarded in the light of a strict interpolation between actual observations; and since the analytical treatment will equalize and remove, in a measure, accidental errors of observation, they may be considered as certainly more trustworthy than any single observation, particularly in cases where the number of observations available for the discussion exceeds half a dozen, properly distributed in relation to time. The probable error of any single representation will be found in the second table. For all ordinary use by the surveyor (or navigator) the tabular values are sufficiently precise; when greater accuracy is required, the annual inequality of the declination and the diurnal variation for the time required must be taken into account. The former correction will probably not exceed, in any case, one minute, and the latter may amount in summer, in maximo, to minus or plus six minutes, and in winter to minus or plus three minutes—numbers which were derived from Prof. Bache's discussion of the Philadelphia observations. The table will also answer for intermediate places, for which they furnish the necessary data of interpolation.

It is proper to state that the present formulæ should be considered as liable to future changes and improvements depending on the accumulation of additional observations; and it is hardly necessary to state that their number also may hereafter be considerably increased by the accession of new material. The utility of a publication of tables showing the declination for

every tenth year was suggested by Mr. T. B. Brooks. In the numerical calculations, I was assisted by Mr. G. Rumpf, of the computing division.

Formulæ expressing the secular change of the magnetic declination (commonly called variation of the magnetic needle) used for calculatiny the tabular values.

Group I.—Stations between Portland, Me., and Williamsburg, Va.—A positive sign of D indicated west declination, a negative sign east declination: n equals the number of years (and fraction of a year) from 1830, positive for years after and negative for years before this epoch. Longitudes are reckoned from Greenwich.

No.	Locality.	Latitude.	Longitude.	
		° ′	° ′	
1	Burlington, Vt	44 27	73 10	$D = +11.55 - 4.10 \cos(1.30\,n + 36°) + 0.21 \cos(7.2\,n + 290°.)$
2	Portland, Me	43 39	70 16	$D = +10.70 - 2.63 \cos(1.33\,n + 87°.)$
3	Portsmouth, N. H	43 05	70 43	$D = +10.20 - 2.45 \cos(1.37\,n + 72°.)$
4	Rutland, Vt	43 36	72 55	$D = +9.89 - 3.66 \cos(1.5\,n + 45°.)$
5	Cambridge, Mass	42 23	71 07	$D = +9.65 - 2.78 \cos(1.30\,n + 71°) + 0.22 \cos(2.7\,n + 290°.)$
6	Newburyport, Mass	42 48	70 49	$D = +9.55 - 2.56 \cos(1.4\,n + 78°.)$
7	Boston	42 20	71 03	$D = +9.16 - 2.55 \cos(1.39\,n + 76°) + 0.22 \cos(3.6\,n + 222°.)$
8	Providence, R. I	41 50	71 24	$D = +9.11 - 2.99 \cos(1.45\,n + 58°) + 0.19 \cos(7.2\,n + 246°.)$
9	Hartford, Conn	41 46	72 40	$D = +8.60 - 3.59 \cos(1.25\,n + 45°.)$
10	New Haven, Conn	41 17	72 55	$D = +8.13 - 3.49 \cos(1.33\,n + 39°.)$
11	Albany, N. Y	42 39	73 43	$D = +7.65 - 2.74 \cos(1.42\,n + 62°.)$
12	Oxford, N. Y	42 27	75 42	$D = +6.55 - 3.69 \cos(1.3\,n + 40°.)$
13	New York	40 43	74 00	$D = +6.47 - 2.32 \cos(1.6\,n + 55°.)$
14	Philadelphia	39 58	75 10	$D = +5.37 - 3.44 \cos(1.6\,n + 39°.)$
15	Hatborough, Penn	40 07	75 08	$D = +5.23 - 3.28 \cos(1.54\,n + 47°) + 0.22 \cos(4.1\,n + 347°.)$
16	Baltimore	39 16	76 35	$D = +2.70 - 2.25 \cos(1.5\,n + 49°.)$
17	Washington, D. C	38 53	77 00	$D = +2.42 - 2.0 \cos(1.5\,n + 49°.)$
18	Williamsburg, Va	37 15	76 40	$D = +2.22 - 2.6 \cos(1.5\,n + 22°.)$

The following table contains the number (n) of observations (single or combined) upon which each formula is based; the probable error (ε_0) of an observation, expressed in minutes, as a measure of the degree of accuracy with which the observations are represented; the epoch of the last minimum of west declination, (or of maximum east declination,) together with the least west declination, (greatest east,) and lastly the annual variation for the years 1840, 1850, and 1860, expressed in minutes. The positive sign expresses west declination increasing, (east diminishing.)

Locality.	n.	ε_0.	Epoch of minimum west declination.	Least west declination.	Annual change.		
					Variation for 1840.	Variation for 1850.	Variation for 1860.
		′		°	′	′	′
Burlington, Vt	9	± 5	1813	+ 7.4	+ 4.1	+ 3.4	+ 4.5
Portland, Me	5	14	1765	+ 8.1	+ 3.6	+ 3.4	+ 3.0
Portsmouth, N. H	4	10	1777	+ 7.7	+ 3.5	+ 3.5	+ 3.2
Rutland, Vt	4	18	1800	+ 6.2	+ 4.9	+ 5.5	+ 5.7
Cambridge, Mass	22	12	1782	+ 6.9	+ 4.3	+ 4.3	....
Newburyport, Mass	4	12	1774	+ 7.0	+ 3.7	+ 3.6	+ 3.3
Boston	8	10	1782	+ 6.7	+ 4.5	+ 4.3	+ 3.7
Providence, R. I	30	5	1779	+ 6.1	+ 5.3	+ 3.8	+ 3.0
Hartford, Conn	6	14	1794	+ 5.0	+ 4.0	+ 4.4	+ 4.6
New Haven, Conn	14	10	1801	+ 4.6	+ 3.8	+ 4.4	+ 4.7
Albany, N. Y	10	3	1787	+ 4.9	+ 3.9	+ 4.0	+ 3.9
Oxford, N. Y.	10	11	1799	+ 3.0	+ 4.0	+ 4.6	+ 4.9
New York	13	13	1795	+ 4.1	+ 3.7	+ 3.9	+ 3.8
Philadelphia	11	16	1805	+ 1.9	+ 4.7	+ 5.3	+ 5.4
Hatborough, Penn	18	5	1796	+ 1.8	+ 4.2	+ 4.3	+ 4.4
Baltimore	3	13	1798	+ 0.5	+ 3.2	+ 3.4	+ 3.4
Washington, D. C	6	8	1798	+ 0.4	+ 2.8	+ 3.1	+ 3.1
Williamsburg, Va	3	15	1815	− 0.4	+ 2.4	+ 3.2	+ 3.7

Table of magnetic declinations for eighteen stations, forming group 1, *on or near the northeastern coast of the United States, between the years* 1680 *and* 1860. *West declination is indicated by a plus sign, east declination by a minus sign, and is expressed in degrees and fractions of a degree.*

Year.	Burlington, Vt.	Portland, Me.	Portsmouth, N. H.	Rutland, Vt.	Cambridge, Mass.	Newburyport, Mass.	Boston.	Providence, R. I.	Hartford, Conn.	New Haven, Conn.	Albany, N. Y.	Oxford, N. Y.	New York.	Philadelphia.	Hatboro', Penn.	Baltimore.	Washington, D. C.	Williamsburg, Va.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1680	....	....	....	......	......	....	....	....	......	....	......	....	+ 8.8	....	+ 8.5	.....	......	......
1690	....	....	....	......	......	....	....	....	......	....	.....	....	8.7	....	8 3	......	......	+4.8
1700	....	....	....	......	+9.9	....	+ 9.7	....	......	....	......	....	8.5	+ 8.8	7.9	......	......	+4.8
1710	....	....	....	......	9.4	....	9.0	+10.4	......	....	.....	....	8.0	8.4	7.5	......	......	.....
1720	....	....	....	......	8.8	....	8.3	9.5	......	....	......	....	7.6	7.9	7.0	......	......	......
1730	....	....	....	......	8.4	....	7.8	8.9	......	....	......	....	7.0	7.1	6.3	......	......	......
1740	....	....	....	......	7.9	....	7.4	8.3	......	.....	......	....	6.4	6.3	5.6	......	......	......
1750	....	....	....	......	7.5	....	7.2	7.7	......	....	......	....	5.8	5.3	4.7	......	.....	......
1760	....	+ 8.1	....	......	7.2	......	7.0	6 9	......	+ 6.1	......	....	5.2	4.4	3.8	......	......	.....
1770	....	8.1	+ 7.8	......	7.0	+ 7.0	6.8	6.3	......	5.5	......	....	4 7	3.5	2.9	......	......	+1.2
1780	....	8 3	7.7	......	6.9	7.0	6.8	6.1	+5.2	5.0	......	....	4.4	2.8	2.2	......	......	0.7
1790	+ 7.8	8.5	7.9	+6.3	6.9	7.2	6.8	6.3	5.0	4.8	......	+ 3.0	4.2	2.2	1.8	......	.....	+0.2
1800	7.5	8.9	8.1	6.2	7.1	7.5	7.0	6.4	5.0	4.6	......	3.0	4.2	2.0	1.8	......	+0.4	—0.2
1810	7.3	9.4	8.5	6.3	7.5	7.9	7.3	6.5	5.2	4.7	+5.4	3.1	4 3	1.9	2.1	+0.6	0.5	0.4
1820	7.6	10.0	8.9	6.7	8.0	8.4	7.8	6.8	5.6	5.0	5.8	3.4	4.7	2.2	2.6	0.8	0.8	0.4
1830	8.30	10 6	9 4	7.3	8.58	9.0	8.41	7.46	6.1	5.42	6.3	3.82	5.16	2.70	3.20	1.2	1.1	−0.2
1840	9.07	11.2	10.0	8.1	9.28	9.6	9.13	8.38	6.7	5.98	7.0	4.43	5.73	3.41	3.89	1.7	1.5	+0.1
1850	9.69	11.8	10.6	8.9	10.0	10.3	9.88	9.14	7.4	6.71	7.7	5.15	6.37	4.25	4.61	2.4	2.0	0.6
1860	+10.30	+12.3	+11.2	+9.9	+....	+10.8	+10.56	+ 9.68	+8.1	+ 7.46	+8.3	+ 5.95	+ 7.01	+ 5.19	+ 5.32	+2.9	+2.6	+1.2

NOTE.—At Cambridge, Mass., the observations after 1855 require further examination. At Williamsburg the values between 1700 and 1770 were not considered sufficiently reliable for insertion. The expression for Baltimore depends for length of period and time of minimum on the Washington formula.

The total number of observations upon which the tabular values and the formula are based is 180; the average number for any one station is 10; and the average probable error of any single representation is $\pm$ 11′.

If we arrange the stations geographically, we find that at the eastern stations the minimum (west) declination occurred earlier than at the more western and southern stations; thus, from six stations, between Portland and Providence, it occurred about the year 1777 in the Connecticut and Hudson valleys, and along the sea-coast as far south as Washington; the year of the minimum does not differ much from 1797; Williamsburg, in Virginia, gives 1815. The transition, as we pass from the New England States, is somewhat abrupt, but too well marked to be accidental. Extending the investigation further north, I find for Quebec, Canada, the year of the minimum 1769; going further west, we find that at Toronto it must have occurred before the year 1842; and at York Fort, Hudson Bay, I find the year 1842, (as already ascertained by Gen'l Sabine, after the receipt of Capt. Blakiston's observations of 1857.) This latter station is nearly halfway across the continent; and if we proceed to the Western Coast, we find that the eastern declination there has not yet reached its maximum, (equivalent to a western minimum,) but it is highly probable that it will reach it before the close of the present century. The present reverse, or western motion of the isogonic lines in our eastern States, which commenced about the year 1777, will gradually be communicated to the more westerly stations, and will, it is highly probable, be participated in on our Western Coast before or at the close of the present century, the direction of the motion in this latter locality being at present still to the eastward and southward, though with a diminishing rate.—(See p. 235 of Coast Survey Report of 1856.)

The following equations, constructed for the two northernmost stations, may be added here:

York Fort, Hudson Bay, $D = + 5^\circ.1 - 14^\circ.2 \cos (1^\circ.6\, n + 340^\circ.)$

Quebec, Canada, $D = + 12.84 - 3.7 \cos (1.6\, n + 97.)$

The second group comprises the stations on the southern portion of the Atlantic Coast and Gulf Coast, only three in number, to which have been added some stations located further south.

Group II.—Southern stations.

No.	Locality.	Latitude.	Longitude.	Magnetic declination.
		° ′	° ′	° ° ° °
1	Charleston, S. C.	32 45	79 51	$D = - 2.12 - 2.02 \cos. (1.55\, n. + 56.)$
2	Savannah, Ga.	32 05	81 05	$D = - 2.95 - 1.24 \cos. (1.5\, n. + 20)$
3	Mobile, Ala.	30 41	88 02	$D = - 6.5 - 0.77 \cos. (1.6\, n. + 16.)$

Locality.	n.	ϵ_0.	Epoch of maximum east declination.	Maximum of east declination.	Annual change. 1840.	1850.	1860.
				°	′	′	′
Charleston, S. C.	5	± 9	1794	− 4.1	+ 3.1	+ 3.2	+ 3.2
Savannah, Ga.	4	12	1817	− 4.2	+ 1.1	+ 1.5	+ 1.8
Mobile, Ala.	6	12	1820	− 7.3	+ 0.7	+ 0.9	+ 1.1

Proceeding in a southerly direction, the next station discussed outside of the boundaries of the United States is Havana, Cuba, latitude 23° 09′, longitude 82° 22′, for which place I found $D = - 4^\circ.82 - 1^\circ.45 \cos (1.3\, n + 26^\circ)$ with 1810 as the year of maximum east declination.

The values collected for Jamaica were not discussed, but the 9 values I was able to obtain will be found in the appended record. For Panama, New Granada, lat. + 8° 57′, long. 79° 29′, the southernmost station discussed, I find $D = - 6^\circ.9 - 1^\circ.04 \cos (1.2\, n + 74^\circ,)$ an equation satisfying the observations, but not considered as preferable to the following expression: $D = - 5^\circ.57 - 2^\circ.21 \cos (1^\circ.2\, n + 34^\circ,)$ which supposes the maximum to occur in 1802.

Going westward and northward, I found for Vera Cruz, Mexico, lat. 19° 12′, long. 96° 09′, $D = - 4^\circ.2 - 5^\circ.04 \cos (1^\circ.1\, n + 7^\circ,)$ with the maximum east declination in 1824.

The following table has been calculated from the preceding equations:

Year.	Charleston, S. C.	Savannah, Ga.	Mobile, Ala.
	°	°	°
1770	− 3.7	....	....
1780	− 4.0	....	....
1790	− 4.1	....	....
1800	− 4.1	− 4.1	− 7.1
1810	− 4.0	− 4.2	− 7.2
1820	− 3.6	− 4.2	− 7.3
1830	− 3.2	− 4.1	− 7.2
1840	− 2.8	− 4.0	− 7.1
1850	− 2.2	− 3.7	− 7.0
1860	− 1.7	− 3.5	− 6.8

Thefollowing formulæ for stations on the Western Coast between San Diego and Cape Disappointment, forming group 3, have been copied from page 234 of the Report for 1856:

No.	Locality.	Latitude.	Longitude.	Magnetic declination.
		° ′	° ′	°
1	San Diego	32 42	117 13	$D = -12.17 - 0.019\,n. + 0.00018\,n^2.$
2	Monterey	36 38	121 54	$D = -14.19 - 0.050\,n. + 0.00047\,n^2.$
3	San Francisco	37 48	122 27	$D = -15.14 - 0.028\,n. + 0.00025\,n^2.$
4	Cape Mendocino	40 25	124 22	$D = -16.29 - 0.029\,n.$
5	Cape Disappointment	46 17	124 02	$D = -19.65 - 0.019\,n.$

The total number of observations used for the construction of the above formulæ is 21, the greatest number for any one station being 6, the least 3; the average probable error of any single representation is $\pm 12'$. The annual change (increasing east declination) may be taken the same for all stations, viz:

	′
In 1840	— 1.6
In 1850	— 1.2
In 1860	— 0.8

Years.	San Diego.	Monterey.	San Francisco.	Cape Mendocino.	Cape Disappointment.
	°	°	°	°	°
1790	— 11.1	— 11.4	— 13.6	— 15.1	— 18.9
1800	11.4	12.3	14.1	15.4	19.1
1810	11.7	13.0	14.5	15.7	19.3
1820	12.0	13.6	14.8	16.0	19.5
1830	12.2	14.2	15.1	16.3	19.7
1840	12.3	14.6	15.4	16.6	19.8
1850	12.5	15.0	15.6	16.9	20.0
1860	— 12.6	— 15.3	— 15.8	— 17.2	— 20.2

The next station discussed, south of California, is San Blas, Mexico, lat. 21° 32′ north, long. 105° 16′ west of Greenwich, which gave the following expression.—(See p. 234, Coast Survey Report of 1856.)

$$D = -8^\circ.63 - 0.042\,n - 0.000\,31\,n^2,$$

which equation, when compared with those above, shows a reversal in the sign of the co-efficient of n^2, or an opposite curvature. The annual easterly increase at San Blas in 1850, according to the above formulæ was $3'.3$ per annum. This station, however, is already within the area of the peculiar form of the isogonic lines, which position may possibly render an immediate comparison impracticable. The station Sitka, in Russian America, is the next place, north of Washington Territory, discussed. I find for it the approximate formula:

$$D = -28^\circ.12 - 0.0607\,n - 0.00025\,n^2.$$

It depends for its latest declination (1858) on the tabular value assigned by Mr. Evans on his late map of the lines of equal magnetic variation reduced to 1858.

Record of all observed declinations made use of in the above paper, not heretofore published in the United States Coast Survey Reports.

The following record containing only additional observations, we have to consult the preceding reports of 1854,* '55, '56, and '58, if we desire to collect all results which may have been used at any one station. The stations are arranged geographically, commencing with the northern and eastern stations, and concluding with the stations on the Western Coast. D = observed declination.

York Fort, Hudson bay.—(From the proceedings of the Royal Society of London, for January, 1858, by Maj. Gen. Sabine.)

1725····D = 19° 00′ W.; Captain Middleton.
1787····· 5 00 W.; Hansteen's map.
1819. Sep. 6 00 E.; Sir J. Franklin.
1843. July 9 25 E.; Capt. Lefroy.
1857. Aug. 7 37 E.; Capt. Blakiston.

Quebec, Canada.

1649····D = 16° 00′ W.; P. Bressau, Hansteen's Erdmag's. Barlow Cycl. Met.
1686····· 15 30 W.; De Hayes " " " "
1810····· 11 00 W.; Becquerel, Traité du magnetisme.
1814····· 11 50 W.; Kent; Becquerel, Traité du magnetisme.
1831····· 13 38 W.; Bayfield; " " " "
1842····· 14 12 W.; Capt. Lefroy.
1859. July 16 17 W.; Chas. A. Schott, Assistant United States Coast Survey.

Burlington, Vt.—(See former observations in 1855 report, pp. 326, 337.)

1837····D = 8° 45′ W.; Prof. Benedict.
1840····· 9 42 W.; J. Johnson; Thompson's History of Vermont.
1845. June 9 22 W.; D. J. Locke; Smithsonian Cont. to Knowledge, Vol. III, 1852.

Portland, Me.

1763····D = 7° 45′ W.; J. Winthrop, Sill's Journal XXXIV, 1838, Prof. Loomis's collection.
1775····· 8 30 W.; J. F. De Barre's Atlantic Neptune, London, 1781.
1845. June 11 28 W.; Dr. J. Locke, Smithsonian Cont. to Knowl., Vol. III, 1852.
1859. July 12 20 W.; Chas. A. Schott, Assistant U. S. Coast Survey. (See also Coast Survey Report of 1856, p. 215.)

Portsmouth, N. H.

1771····D = 7° 46′ W.; Holland; Sill's Journal XXXIV, 1838; Prof. Loomis's collection.
1771····· 7 48 W.; Holland.
1775····· 7 45 W.; J. F. De Barre's Atlantic Neptune.
1859. July 11 15 W.; Chas. A. Schott, Assistant U. S. Coast Survey. (See also Coast Survey Report of 1856, p. 215.)

Rutland, Vt.

1789. Apr. D = 7° 03′ W.; Dr. Williams; Sill's Journal, XVI, 1829.
1810. May 6 04 W.; " " "

* The table of the declinations in that report is reprinted and enlarged in the report of 1855.

1811. Sept. D = 6° 01′ W.; Dr. Williams; Sill's Journal, XVI, 1859.
1859. July 9 49 W.; Chas. A. Schott, Assistant U. S. Coast Survey.

Cambridge, Mass.—(See pp. 317, 318 of Coast Survey Report of 1855; also Coast Survey Report of 1856, p. 222.

1845. June D = 9° 32′ W.; Dr. J. Locke; Smithsonian Cont. to Knowl., Vol. III, 1852.
1855. May 10 54.6 W.; W. C. Bond, (in a letter to Superintendent of Coast Survey.)
1856. May 10 50.3 W.; " " " " "
1856. July 10 06 W.; Karl Friesach, Imp. Academy of Sciences, Vienna, Vol. XXIX, 1858.

NOTE.—More recent observations still require examination.

Newburyport, Mass.

1775····D = 6° 45′ W.; J. F. W. De Barre's Atlantic Neptune.
1781···· 7 18 W.; Dr. Williams; Sill's Journal, XXXIV, 1838, Professor Loomis's collection.
1859. July 10 58 W.; Chas. A. Schott, Assistant United States Coast Survey.
(See also Coast Survey Report, 1856, p. 215.)

Boston, Mass.

(See Coast Survey Report, 1855, pp. 316, 317, 337.)

Providence, R. I.

(See Coast Survey Report, 1855, pp. 307, 308, 309, 337.)

Hartford, Conn.

1786····D = 5° 25′ W.; Dr. Williams;
1810···· 4 46 W.; Asher Miller;
1824···· 5 45 W.; N. Goodwin;
1828···· 6 03 W.; N. Goodwin;
1829···· 6 03 W.; N. Goodwin;
Professor Loomis' collection in Sill's Journal, Vol. XXXIV, 1838.
1859. July 8 04 W.; an interpolated value from observations at Springfield and New Haven in 1859 and 1855.

New Haven, Conn.

(See Coast Survey Report, 1855, pp. 319, 320, 337.)

Albany, New York.

1847. Nov. D = 7° 35′ W.; Regent's Report, (geological survey.)
1856. Sept. 8 35 W.; Karl Friesach, Imperial Academy of Sciences, Vienna, Vol. XXIX, 1858.
(See also Coast Survey Report, 1855, pp. 328, 337; and Coast Survey Report, 1858, p. 191.)

Oxford, New York.—The following observations, marked E. B. W. C., are from a letter of Mr. E. B. W. Call to the Superintendent of Coast Survey, December 22, 1858:

1792–95··D = 3° 00′ W.; E. B. W. C.
1817···· 3 00 W.; E. B. W. C.
1828. July 4 30 W.; E. B. W. C.
1834. Oct. 3 52 W.; Regent's report; Sill's Journal, XXXIV, 1838.
1836. Oct. 4 09 W.; Regent's report; Sill's Journal, XXXIV, 1838.
1838. July 4 30 W.; Regent's report; observed at Guilford.
1849. Nov. 5 11 W.; E. B. W. C.

1857. Apr. = 5° 44′ W.; E. B. W. C.
1858. Feb. 5 47 W.; E. B. W. C.
1858. Dec. 5 50 W.; E. B. W. C.

New York.

(See Coast Survey Report of 1855, pp. 320, 321, 333, and 337; also Coast Survey Report, 1856, p. 217.)

Philadelphia.

(See Coast Survey Report of 1855, pp. 313, 314, and 337.)

Hatboro', Pa.

(See Coast Survey Report of 1858, pp. 192, 193, 194, and 195.)

Baltimore, Md.

1808····D = 0° 10′ to 15′ W.; D. Byrnes, Vol. XVIII, 1830, Sill's Journal.
(See also Coast Survey Report, 1856, pp. 219, 227; also Coast Survey Report, 1858, p. 191, Washington, D. C.)

Washington, D. C.

(See Coast Survey Report, 1858, pp. 195, 196, 197.)

Williamsburg, Va.

1694····D = 5° 00′ W.; Sill's Journal, Vol. XXXIV, 1838, Prof. Loomis' collection.
1780···· 0 50 W.; Sill's Journal, Vol. XXXIV, 1838, Prof. Loomis' collection.
1809···· 0 33 E.; Sill's Journal, Vol. XXXIV, 1838, Prof. Loomis' collection.
1856. Aug. 1 04 W.; deduced from observations at Petersburg, Old Point Comfort, and Norfolk.

Charleston, S. C.

1857. Apr., D = 1° 56′ E.; derived from observations at Savannah in 1852 and 1857.
(See Coast Survey Report, 1855, pp. 322, 323.)

Savannah, Ga.

1817····D = 4° 00′ E.; Becquerel, Traité du magnetisme.
1838···· 5 05 E.; Sill's Journal, XXXIX, 1840.
1839···· 3 31 E.; Sill's Journal, XXXIX, 1840.
(See also Coast Survey Report, 1856, p. 220, and Coast Survey Report, 1858, p. 192.)

Mobile, Ala.

(See Coast Survey Report, 1855, p. 323; also Coast Survey Report, 1858, p. 192.)

Havana, Cuba.

(See Coast Survey Report, 1855, p. 324.)
1357. January, D = 5° 15′ E.; Karl Friesach, Imperial Academy of Sciences, Vienna, Vol. XXIX, 1858.

Jamaica, West Indies.

1732····D = 6° to 6° 5′ E.; J. Harris, at Black river in March and April, Phil. Trans., 1733.
1789–1793 6° 50′ E.; J. Leard, map of Port Royal.
1791–1792 6 45 E.; J. Leard, map of Port Royal.
1819···· 4 50 E.; De Mackau, Becquerel's traité du magnetisme, Paris, 1846.
1821···· 4 50 E.; De Mayne, Becquerel's traité du magnetisme, Paris, 1846.

1822· · · · · 4 54 E.; Owen, Becquerel's Traité du Magnetisme, Paris, 1846.
1832· · · · · 5 13 E.; Foster, Becquerel's Traité du Magnetisme, Paris, 1846.
1833?· · · · 4 40 E.; from a map.
1840?· · · · 4 00 E.; General Sabine's isogonic map of the Atlantic Ocean.
1857. Mar. 3 40 E.; Karl Friesach, Imperial Academy of Sciences, Vienna, vol. XXIX, 1858.

Panama, New Granada.

1775. Nov., D = 7° 49′ E.; Encycl. Brit.
1791. Dec. 7 49 E.; Encycl. Brit.
1802· · · · · · 8 00 E.; Encycl. Brit.
1822· · · · · · 7 00 E.; Hall, Becquerel's Traité du Magnetisme.
1837· · · · · · 7 02 E.; Sir E. Belcher.
1849· · · · · · 6 55 E.; Major Emory, (Mexican boundary survey.)
(See also Coast Survey Report, 1856, p. 223.)

Vera Cruz, Mexico.

1726–27· · D = 2° 15′ E.; J. Harris, Phil. Trans. R. S., anno 1728.
1769· · · · · 6 40 E.; Ency. Brit., 7th edition, 1842.
1769. Mar. 6 28 E.; Ency. Brit.
1776· · · · · 7 30 E.; Don Ulloa, Ency. Brit.
1815· · · · · 10 37 E.; Malony, Ency. Brit.
1819. Apr. 9 16 E.; Wise, Ency. Brit.
(See also Coast Survey Report, 1856, p. 214.)

San Diego, Monterey, San Francisco, and Cape Mendocino, Cal., and for *Cape Disappointment, Washington Territory.*

(See Coast Survey Report, 1856, pp. 228 to 235.)

Sitka, Russian America.

1804· · · · · D = 26° 45′ E.; Lissiansky, } Becquerel's Traité du Magnetisme.
1824· · · · · 27 30 E.; Kotzebue,
1829· · · · · 28 19 E.; Erman,
1858· · · · · 30 00 E.; from Evans' map of isogonic lines for 1858.

Yours, very respectfully,

CHAS. A. SCHOTT,
Assistant Coast Survey, in charge C. D.

Capt. W. R. Palmer, *T. E.*
Assistant Coast Survey, in charge of office.

APPENDIX No. 25.

Gulf Stream explorations.—Third memoir: Distribution of temperature in the water of the Florida channel and straits: By A. D. Bache, Supt. U. S. Coast Survey. (Communicated, by authority of the Treasury Department, to the American Association for the Advancement of Science.)

The results of the explorations of the Gulf Stream in the survey of the coast have been communicated to the Association from time to time, as phenomena of peculiar interest have been developed.

The original plan of these explorations having been carefully studied, and having proved successful, has steadily been adhered to. The more recent observations have been directed to that part of the stream, between Havana and Cape Florida, known as the channel and strait of Florida. I have now to present four sections, showing the depth and temperature in this most important region of the Gulf Stream. These results are from the observations of Commander B. F. Sands and Lieut. Comg. T. A. Craven, U. S. N., assistants in the Coast Survey, whose names have already been mentioned before the Association in connection with explorations of the Gulf Stream, and furnish a sufficient guarantee that the results have all the reliability which care, experience, and zealous labor could give them.

Section No. 1, (Sketch No. 35,) from Cape Florida to Bemini, was run by Lieut. Comg. Craven in May, 1855; Section No. 4 by Commander Sands in May, 1858; and Sections Nos. 2 and 3 by Lieut. Comg. Craven in April and May of the present year, 1859.

Sections 2, 3, and 4 are perpendicular to the direction of the stream at distances of about fifty, one hundred, and two hundred miles from Cape Florida. The lines of sections are shown upon the chart marked A. The Florida strait is funnel-shaped, being about ninety miles wide at Havana and about forty-five miles wide at Cape Florida, the narrowest part.

Form of bottom.

The area of the water way and the form of the bottom are represented on diagrams 7, 8, 9, and 10, (Sketch No. 35.) The Arabic numerals at the top represent distances from the Florida coast (the keys) in miles, and the numbers below them the positions at which observations were made. The numbers at the left hand represent the depth in fathoms.

Commencing at the Cape Florida section, it will be seen that there is a rapid descent of the bottom to the Havana section, from three hundred and fifty fathoms to eight hundred fathoms, or twenty-seven hundred feet in a distance of two hundred miles. The most shallow, as well as the narrowest part of the stream, is, therefore, at Cape Florida. The deepest water follows the coast of Cuba and the Grand banks, the depth being eight hundred fathoms at a distance of only five miles from Havana, nearly four hundred fathoms within five miles of Salt Key bank, and three hundred fathoms close to the island of Bemini. The descent from the Florida side is for the most part gradual, but from the opposite side abrupt. This effect seems to have been produced by the action of the sub-current in wearing a deeper channel upon the concave side of the stream. At Havana there is an abrupt descent of nearly a mile within five miles of the shore, while on the side of the Tortugas and Key West the water is comparatively shallow and the descent gradual. This fact goes to confirm the conclusion that the stronger current

of the Gulf Stream makes the circuit of the Gulf of Mexico; since, if it impinged directly upon the islands of Key West and the Tortugas, we should find its effects in the wearing of a deeper channel on that side.

Temperatures.

Change of temperature with depth.

In a former communication the law of change of temperature with depth was discussed, and types of the curves representing the law were given for different parts of the stream. These curves were all merely modifications of a more general form. Thus, the cold water between the Gulf Stream and the coast gave one form, the axis of the stream another, and the water beyond the axis a third form, while in the Strait of Florida a fourth was developed. It would be natural to expect, in the course of many years' explorations by different individuals, with different instruments, not even of the same class, that general phenomena of this character should present some contradictions and some inexplicable results.

Experience, however, has confirmed the first conclusions and the constancy of the phenomena. It is not difficult, having the curve representing the temperatures at any position from the surface to the depth of several hundred fathoms, to determine, from the temperatures alone, in what part of the stream they were taken.

Temperature in a direction perpendicular to the stream.

Diagrams 2, 3, 4, and 5 (Sketch No. 35) show the changes of temperature for the same depth in each of the sections, and diagrams 7, 8, 9, and 10 the depth for the same temperature.

Bands of warm and cool water.

In the section from Cape Florida to Bemini the division of the stream into bands is plainly exhibited, though more faintly than in the northern sections, and the form of the bottom in this section shows also elevations and depressions corresponding to the divisions. In the sections south of Cape Florida all traces of the bands seem to disappear, as well as the ridges of the bottom. The bands, therefore, seem to have their origin near Cape Florida; and the conclusion stated some years ago as the probable one is strengthened, that they are caused by the ridges aud valleys of the bottom parallel to the general course of the stream, and along which the stream and counter-stream have their course.

The Cold Wall.

The Cold Wall, as an exception to the remark made above in reference to the bands, is traced as far as the Tortugas, and is plainly shown in all the sections with more or less distinctness. In the Sombrero key section (No. 3) it is strongly marked at depths ranging from seventy to a hundred fathoms, while in all the sections the warm water at the surface overflows the Cold Wall and reaches quite to the shore.

Diagram No. 6 represents the comparative curves of the Cold Wall in different sections of the Gulf Stream, including those in the Straits of Florida. The figures at the top show the distances of the cold wall from the shore in the different sections, and the numbers on the left the degrees of temperature. The curves are drawn for different depths in the several sections, as shown in the notes at the bottom of the diagram. The dotted curves, *g*, *h*, *i*, *k*, represent the Cold Wall in the four sections under consideration.

Longitudinal sections.

It has been found very difficult to deduce any satisfactory law for the decrease of surface temperature along the axis of the stream, owing to the variability of the temperature of the waters of the regions from whence the Gulf Stream is supplied. Two modes of investigating the subject have been pursued; one, by following the stream from the Gulf of Mexico, and making hourly observations of the temperature of the water, and the other by comparing the mean temperatures of the various sections with each other and with the temperature of the Gulf of Mexico. In the first method the vessel must be allowed to drift with the current of the stream, a difficult condition except in the best weather, even for a day, and to float along thus for hundreds of miles would rarely be practicable. Any motion communicated by sails or by steam must carry the vessel beyond the water in which she commenced her voyage, and the lateral overflow carries the water constantly from the axis towards the edges of the stream. In the comparison of mean temperatures of the different sections the fact has been established that the temperature of the water of the stream at any point may be higher than at a point nearer the source, and hence vessels in running along the stream may, and generally do, pass through water not of a constantly diminishing temperature, but from cool to warm, and the reverse. This is to be explained mainly, though not entirely, by the variability of temperature at the source.

By taking the mean temperature of any one section and going back to the date of the departure of the waters from the Gulf of Mexico as determined by the velocity of the stream, and comparing the temperatures observed with the temperatures of the Gulf waters, it was supposed that a solution of the question might be obtained. The temperatures were taken from the most authentic meteorological records of the Gulf for a series of years, and those periods sought which corresponded to the dates desired. The uncertainty of the temperatures of the waters of the Gulf of Mexico, as obtained from air temperatures taken here and there along its shores, rendered the results unsatisfactory. Enough seems to have been determined, however, to show that the surface temperature of the Gulf Stream along its course is variable; that a vessel sailing along the axis at a more rapid rate than the motion of the stream will pass through water of higher and lower temperature, depending generally upon two conditions, viz: the distance from the Gulf of Mexico, and the temperature of the Gulf at the time the water entered the straits of Florida; and further, that the latter cause is the predominating one in the parts of the Gulf Stream adjacent to the Atlantic coast, where the current is rapid.

The influence of the form of the bottom in forcing the cold counter current of the bottom upward has been adverted to, and the fact appears to be well established in the cross sections, where the ridges and valleys parallel to the direction of the stream separate it into bands of warmer and cooler water, and this conclusion, as has just been stated, is strengthened by the fact that the bands and ridges simultaneously disappear south of Cape Florida. This phenomenon is moreover strikingly exhibited in the longitudinal section of the bottom in connection with the lower temperatures.

The shallowness of the stream in the Strait of Florida, connected with the fact that the bottom falls off rapidly to the north and south, afforded an excellent opportunity for testing this question. If the cold water of the under polar current follows the bottom it should appear in the shallow part of the strait, and here the warm water of the surface and the cold water of the bottom would approach each other. Diagram No. 1 shows the curves of 40°,

45°, and 50° (bottom temperatures) along the deepest part of the stream, commencing at Sandy Hook and running as far as the Tortugas. All these curves rise with the bottom and pass over the ridge which divides the bed of the Atlantic from that of the Gulf of Mexico, and again fall with the slope of the bottom towards the Gulf. In the narrowest part of the strait, where the depth is three hundred and fifty fathoms, the temperature, from the surface to the bottom, ranges between 80° and 40°.

On the effects of pressure on Saxton's Deep-sea thermometer.

In the explorations of the Gulf Stream the temperatures below one hundred fathoms have mostly been determined by Saxton's metallic thermometer, and although the results have been consistent amongst themselves, and have agreed well with the indications of other thermometers, yet it was thought advisable to determine the effect of pressure by direct experiment.

Saxton's thermometer consists essentially of a compound ribbon of silver and platinum, fused and pressed together by rollers. This ribbon is wound in a spiral form, one end of the spiral being firmly fastened to an interior solid axis, and the other left free. Upon the free end is placed an index arm, which moves over a circular graduated scale, carrying with it a friction hand or indicator, which is left at the extreme point of the arc reached by the true index. The instrument is enclosed in a case, to which the water is freely admitted. A variation of temperature is immediately noticed, as the effect is to give a rotary motion to the index.

The experiments to determine the effect of pressure were made at my request by Mr. J. M. Batchelder, with means devised by Mr. Thomas Davison at the Novelty Iron Works. The following description of the apparatus employed is given by the last named gentleman.

"The gauge (Sketch No. 35) consists of a brass cylinder H about eight inches long, into which a steel plunger is fitted, the upper part of the plunger at A being .70 of an inch in diameter, and the lower at B about .786, so that the difference in area of the ends is equal to one-tenth of a square inch. The cylinder is bored out a little larger than the plunger, except for about a fourth of an inch near each end, at C and D, where both are accurately fitted. To the branch E a pipe connects, communicating with the hydraulic cylinder, and leading the water into the centre of the gauge, which it reaches after passing through the chamber F, filled with sponge to prevent any impurities in the water from reaching the plunger. The upper end of the plunger connects by a wire W to a spring, as shown in the sketch at G, so constructed as to indicate pressure from 0 to 450 pounds, the spring being so strong that 450 pounds produce a movement of the plunger equal to three-eighths of an inch. It is evident that, as the difference in area of the ends of the plunger is one-tenth of an inch, one hundred pounds pressure from the water on this surface, as indicated by the balance, would equal a pressure of water of 1,000 pounds per inch, or a pressure ten times as great as that indicated by the balance throughout its scale. The only difficulty in the use of the gauge is that of fitting the plunger to the cylinder, so that, while it is perfectly free to move, it is also water-tight. This difficulty, however, has been overcome, and much advantage was also derived from Mr. Batchelder's suggestion for supplying the wear of the plunger and cylinder by depositing brass on the plunger through the galvanic process."

Connected with this gauge by a pipe is a strong wrought-iron cylinder sixteen inches long by four inches in diameter, in which the thermometer was placed, the opening being firmly closed by a screw plug. This second cylinder was immersed in a tub of water for the purpose

of regulating the temperature. The thermometer once placed in the cylinder is not again removed, the index being read by means of a mirror until the observations are completed.

By the use of this apparatus the effect of pressure up to 4,000 pounds per square inch was observed upon two thermometers, and the results are given below. The observations were made to indicate the effects of 500, 1,000, 1,500, 2,000, 2,500 pounds pressure, &c. Seven series of experiments were made with thermometer No. 5, and five series with No. 10. The mean results show that a pressure of 1,000 pounds per square inch has no effect upon the thermometer; at 1,500 pounds the effect is less than one degree; and from 1,500 to 4,000 pounds per square inch the effect is to diminish the readings, the maximum effect being seven degrees.

The diagram (Sketch No. 35) exhibits the law of diminution by increase of pressure, and the depth corresponding to different pressures. The correction to be applied varies with the depth. For thermometer No. 5 it is only four-tenths of a degree Fahrenheit at the depth of 600 fathoms. For thermometer No. 10 it is one degree at the same depth. At 1,500 fathoms the corrections are respectively five and a half and seven degrees.

Nearly all the temperatures observed in the Gulf Stream have been taken at depths less than 600 fathoms.

Table showing differences of readings of Saxton's thermometer, under pressure and free from pressure.

THERMOMETER No. 5.

Number of series.	PRESSURE IN POUNDS.					
	1,500.	2,000.	2,500.	3,000.	3,500.	4,000.
	°	°	°	°	°	°
1	1.6	0.00	3.75	0.00	0.00	0.00
2	0.	1.00	2.	2.8	4.5	5.5
3	0.	1.00	2.25	3.75	4.75	5.7
4	0.	0.5	0.5	2.0	3.6	5.5
5	0.	1.75	2.25	3.5	5.0	6.5
6	0.	1.25	2.25	3.75	6.0	6.5
7	0.5				3.5	4.25
Means	0.3	1.1	2.1	3.2	4.5	5.6

THERMOMETER No. 10.

Number of series.	PRESSURE IN POUNDS.					
	1,500.	2,000.	2,500.	3,000.	3,500.	4,000.
	°	°	°	°	°	°
1	0.00	2.00	3.25	4.5	6.25	8.25
2	2.00	1.00	3.5	4.5	6.00	7.25
3	0.75	2.00	3.0	3.25	5.5	6.5
4	1.75	2.00	3.5	4.75	5.5	7.25
5	0.75	1.75	1.75	3.75	5.0	6.75
Means	1.00	1.75	3.00	4.25	5.6	7.25

APPENDIX No. 26.

Report of Assistant Henry Mitchell on the physical surveys of New York harbor and the coast of Long Island, with descriptions of apparatus for observing currents, &c.

BOSTON, *September* 30, 1859.

SIR: I have the honor to inform you that the field-work comprehended in your plan for the physical survey of New York harbor has been completed by the operations of the past season.

At the commencement of this work it was quite impossible to foresee the form it would ultimately assume, the questions to which it would give rise, or the investigations to which it would lead. Neither the precise character of the observations to be made, nor the extent to which they should be carried, could be estimated in an undertaking in many respects quite novel and without precedent.

Certain changes in the forms of shoals and channels had been revealed by the comparison of the early surveys with those of more recent date, and the questions arose—To what causes are these changes due? and—To what end do they progress? What are the natural forces which build in one direction shoals and beaches, while opening elsewhere new channels, or wearing away the shores? These were the problems for the solution of which the physical survey was instituted.

The general plan of this work, to which you first directed my attention, has been adhered to throughout; since your subsequent instructions have referred to the limits of each season's work, rather than to the character of it. By this plan we have been required to observe, and make note of, every natural operation, whether of tides, currents, winds or waves; in fine, to compile for a certain period a complete physical history of these elements from a systematic course of inquiry.

The field over which our observations have spread includes not only the harbor proper, but its approaches in all directions, extending up the Hudson river to Fort Washington, into Long Island sound as far as Execution light, through the kills, over the bar, and sixty miles out to sea. Throughout this field the periods, velocities, and paths of the various currents are determined, as are also the experiences of the tide waves (both from the sound and the ocean) in the different channels and avenues which they traverse. The disturbing effects of winds and freshets, the appearance of rips and eddies, together with general meteorological phenomena, have all been noted carefully.

The whole number of tidal and current stations which we have occupied exceeds one hundred and fifty, and at these the observations number many thousands. Many of the tidal stations were occupied one or more entire lunations, and at some of the current stations the observations were continued in unbroken series of half-hourly records for seven, nine, and fourteen days. The aggregate amount of time spent on the field-work has not exceeded twelve months.

Rough computations of our observations were made in the intervals between the working seasons, and these acquainted us with the progress we were making, and pointed out the direction which succeeding inquiries should take. From the results of our labors we gained at each step confidence and encouragement. What appeared at first a tangled skein of accidental or inconstant causes, we ultimately recognized as orderly and harmonious relations; and, our

methods of observing improving steadily, the work advanced to its close at a pace constantly accelerated.

The observations of the past season were confined to no special locality, but were made at various points where previous operations were incomplete or required connecting links.

Our field-work commenced the first of June, and the quiet weather which prevailed during this month was improved for the occupation of the more exposed stations—those near shallow portions of the bar and along the outside coast. We had designed to occupy a station which should, if possible, lie quite beyond the reach of the New York harbor drift, and enable us to determine whether any oceanic current sweeps into the great bay formed by the coasts of Long Island and New Jersey. For this purpose we anchored, in thirty fathoms water, nearly sixty miles east-southeast of Sandy Hook, where, during a period of fifteen hours, we measured the currents at the surface, and at depths of twenty-three and one hundred and fifty feet, besides a few determinations of the mean motion for the entire depth. At this station, nearly forty miles from the nearest land, we found regular tidal currents, nearly as strong as those observed at the light-ship the previous season. No oceanic current could be detected, but the augmentation of the ebb current, caused by the drainage of the land waters, was very appreciable. The velocities of the currents are not so regular at this station, from the fact that the depth of the moving water stratum is variable, at one time extending to the bed of the sea, at another reaching but a short distance below the surface. The directions of the flood and ebb drifts were found to be respectively west-southwest and east by south; which, making due allowance for the disturbing effects of the land waters, would indicate that the tide-wave has here a westerly motion. The land waters of which we have spoken are doubtless the combined drainage from New York harbor and the various inlets; for, extending our observations along the south shore of Long Island, we found that they outlive the tidal currents, and establish themselves as a constant coastwise stream along the eastern portion of Fire Island beach.

The stations outside of the bar were eleven in number, at which above seventeen hundred observations were recorded, and of these more than five hundred were made at points below the surface.

The greater part of our season's work lay in the lower bay or in the vicinity of the bar, where there remained some localities unexamined and others at which previous examinations had given discordant results.

From the computations which followed the field-work of 1858, it appeared that where observations were sufficiently numerous the causes of a certain class of shoals were immediately deducible from the data obtained. It was ascertained, on making a composition of the currents at each station, with the assumption that they are to be regarded as forces acting simultaneously, that the resultants take directions towards the shoals as focal points; making it evident that the sand which forms these shoals is gradually swept together from the neighboring channels. Simple as the dynamics of this natural process may be, its form can only be developed from the most accurate determinations of the elements. The resultant, for instance, may be a very small quantity from a station at which the adverse currents are very violent. In a case like this, the slightest error of observation, or even the selection of an unsuitable period, may give us a false result and lead us entirely astray. If the observations are not sufficiently frequent, they may fail to give the exact durations of certain phases of the currents; or if the positions

of the stations are not closely determined, errors enter into the directions of the forces. Again: if the observations are not continued long enough to eliminate the diurnal inequalities, an undue weight will be given to some of the elements which enter into the problem. At the commencement of the past season, forewarned of these difficulties, I placed in the hands of my observers printed rules for their guidance, and required of each person a strict conformity to them. Twenty-one stations were occupied in the portion of the work to which I have just referred, and at these the aggregate number of observations reaches nearly five thousand, of which above eighteen hundred are from points below the surface. At these stations the observations were usually kept up in unbroken series of twenty-five hours each.

A more suitable period for observations of so exact a character could scarcely have been chosen; our operations were rarely suspended by bad weather, and few delays of any kind occurred.

In making observations upon bars and shoals, the disturbing effects of strong winds cannot be disregarded; for it not unfrequently happens that they change the direction of the current, or wholly reverse its course. In districts of shallow water the waves created by the winds have a motion of translation whose effect upon the log is very great; and although the observer is able to distinguish this sudden and uncertain motion from that of the more steady current, he cannot introduce a correction for it. Where the sea is deep, the impulses it receives from the winds result in simple undulations, giving to the log no horizontal motion whatever, so that, even when the swell is very heavy, accurate current observations are possible. As far as our experience has gone, we have never observed in the waves any power of transportation where the depth of water exceeds three fathoms.

Above the Narrows there were eight stations occupied—three in the main channel of the harbor, two in the Hudson, and three in the East river. At these there were recorded over seventeen hundred observations, of which above eight hundred were made upon the sub-currents.

The stations in the harbor, as well as those in the Hudson river, were designed to furnish us with additional data relative to a class of remarkable counter-currents discovered the previous season. The former observations had established the fact that along the main channel the currents of the lowest water stratum maintain velocities and directions quite at variance with those near the surface. It, however, remained to be proved whether the phenomena observed were continuous from station to station or mere local conditions; and if their continuity could be shown, the exact limits of their domain were to be ascertained. The information now in our hands affords, I am convinced, a full and faithful exhibit of these points.

The three stations in the East river lie in positions which the previous work had shown to be important, as embracing the terminus of the Hell Gate interference current. At one of these stations, which lies in the deep basin westward of the point of Blackwell's island, some curious conditions of the sub-currents manifested themselves. Here the axis of the ebb (westerly) drift was observed to lie about twenty feet below the surface throughout the entire duration of this current; in other words, the current is stronger at this depth than at any other point above or below. There are resemblances between this phenomenon and those already referred to as appearing in the main channel of the harbor, but I am doubtful whether we can class them together. In the discussion of our results, we propose to group the currents of the upper harbor according to tidal hours obtained from the self-registering gauge at Governor's

island, and those of the lower harbor and its approaches, according to tidal observations made simultaneously by some of our own party at Sandy Hook.

The closing work upon the physical survey of New York harbor, which we have briefly described, did not occupy us during the entire season, and there proved to be ample time for the other operations directed by your instructions, viz: inquiries into the physical conditions of the bays and inlets along the south shore of Long Island.

Glancing at a chart of our coast, one may see on the south shore of the island of Nantucket a series of small ponds separated from the sea by narrow reaches of sand. On Martha's Vineyard the same features may be observed along the outer shore, except that here the larger basins or lagoons have occasional outlets through the strips of sand beach. Further to the westward, upon the coast of Long Island, appear similar basins, so extensive as almost to form inland seas with outlets of considerable depth, through which vessels may pass. Here are fully established the forms which may be distinguished as the leading characteristics of the Atlantic coast to the southward, and of the entire Gulf shore. From the past history of the sandy portion of our sea-coast, it appears that the outlets to which we have referred are never permanent, but continually shift their positions, either by gradual encroachments and recessions of the sand reaches, or by suddenly closing up at one point and breaking away at another. The design of our study was to ascertain, if possible, the causes which maintain these extended sandy reaches, and the agencies which create the channels through them. In this undertaking, the line of stations, to which reference was made in the former part of this report, extending along the coast, at intervals of from five to twelve miles from Coney island to a point twenty-five miles east of Fire Island light, gave us all the requisite data for a complete knowledge of the shore currents; and we added to these series of current observations at Fire island, Crow Gut, and Rockaway inlets, besides others from stations in the Great South bay. By half-hourly records at gauges temporarily erected, the form of the tide wave as it enters Fire Island inlet was compared with that observed at Sandy Hook on the one hand, and that at the eastern extremity of the Great South bay upon the other. At some of the outside stations we threw over sinking articles, hoping to find them again upon some portion of the beach, and thus be able to determine the direction of the movements on the bottom of the sea. The first class of articles we tried were balls made of cement, with corks enclosed, giving them what we supposed to be the requisite specific gravity. On a former occasion these cement balls were used quite successfully along the shores of Sandy Hook, but we now found them to fail entirely on this coast, where the currents are more feeble. We subsequently had recourse to the large skimmer shell *(mactra solidissima)* which we collected from the shores, and marked with drills. Some of these, cast over in three fathoms water off Oak Beach, travelled eastward, and crossing Fire Island inlet, were swept on shore four miles to the eastward of their place of deposit. In the performance of this journey they were occupied over two weeks, during a prevalence of easterly winds. Of three hundred shells cast into the sea, one hundred were recovered—a much larger proportion than we could possibly have expected to find among the shifting sands and the miscellaneous stranded articles upon these beaches. The easterly preponderance in the movements of the currents along the bed of the sea, which the journey of these shells revealed, corresponds with the results from previous observations of the surface drifts

As our inquiries proceeded, it became evident that the currents, powerful though they may be to scour channels and form the ocean bed, cannot alone effect the peculiar changes which are observed to take place in the beaches, but that the waves take a part, not insignificant, in

these operations. In the shallow waters along these alluvial shores the waves, driving in from the ocean, acquire violent horizontal movements, and dash along the beach with a force in comparison with which the strongest currents are quite impotent. In order that we might the better understand and determine the precise action of the waves and the relation of their office to that of the current, we made a very careful examination of the conditions in miniature forms of bays and inlets, where the limited field of observations afforded us a comprehensive view of the natural activities at work. The results of this examination have already been laid before you with such conclusions from them as were immediately obvious.

In the course of this and former reports I have referred repeatedly to the observations of currents at different depths, and it has occurred to me that some description of the apparatus in use should here be given, in order that the reliability of the results should be established.

Descriptions of Apparatus.

For observations upon the surface currents we use a "tube-log," which is simply a tin cylinder four inches in diameter and six feet long. This tube is partially filled with water, so as to sink nearly its whole length and maintain an upright position; and a graduated line being attached, the observations are made as with an ordinary ship's log. We have found that a log of less draught than this is liable to be affected by the wind.

When we desire to obtain the mean motion of a stratum of greater depth, we use twenty-four feet tubes, and in some cases those as long as forty-eight feet.

If the velocity of the current in the lowest water stratum is desired, we take the following course: Two copper globes of equal dimensions are connected by wire rope of the smallest possible size compatible with the strength required. One of these globes, being filled with water, is allowed to sink the whole length of the connecting line, while the other, being empty, or only partially loaded, swims at the surface of the sea. To the upper globe the log line is secured. The velocity with which the globes, thus connected, will move, is a mean of the rates at which the upper and lower water strata are flowing; and if simultaneous observations are made with this apparatus and the surface log, before described, we are furnished with the means of obtaining by calculation the velocity of the lowest stratum. This method may be employed where the water is not so deep as to give to the connecting wire rope an extent of surface which, exposed to the current, may require consideration in the problem.

The instruments I have described thus far are similar to those which have been used in determining the discharge of canals in Europe. In the application of these to inquiries on a larger scale, I have found it necessary to make certain modifications of them to insure accuracy.

It not unfrequently occurs that the velocity of the surface drift is many times greater than that of the lower stratum, or holds altogether a reverse direction, so that the motion of the globes is quite at variance with that of the surface log. In a case like this, the graduated line secured to the globes is borne away by the surface current, and the observer is deceived. The full extent of this difficulty will be appreciated when it is considered that the line of which I have spoken is necessarily of considerable size, the strength of six men being sometimes required to draw in the globes. I propose to obviate this difficulty by the following arrangement: Within the upper globe, made of wood in this case, a reel is placed, upon which a small log-line, passing in at an aperture at the pole, is wound by a crank from without. The extremity of this log-line is secured to a third globe, which swims freely upon the surface of the sea. When making an observation, the log-line is wound up until the floating globes are

brought together; then, at a signal, the reel is loosened; and now, if the surface and su b currents differ in velocity, the free globe separates from the others, and the observer notices the number of divisions of the log-line drawn out in thirty seconds. In this experiment the apparatus is in nowise connected with the vessel, but the observer follows in a boat until the trial is completed. Figure 1 (Sketch No. 40) shows the relative position of these globes during the course of the observations. In this figure A and B are the connected globes, while C is the free float. The weight of the globe B causes the swimming globe A to sink nearly to its pole, and the free float C is loaded so as to sink about the same distance. The graduated line, which measures the separation of the floating globes, may be seen, one end fastened to a ring upon the free float C, the other passing in at the pole of the globe A. Figure 2 is an enlarged representation of the globe A, opened so as to show the reel within. The water, which enters the globe freely, acts as a check, preventing this reel from acquiring an undue momentum with any sudden jerk of the line caused by the waves. In this figure may be seen the position of the crank by which the reel is wound; this crank is, of course, removed after the floating globes are drawn together. Upon the outside of the globe containing the reel every ten degrees are marked that the observer may note in his record the amount submerged. In the reduction of these observations the extent of the wetted surfaces of the two connected globes must be considered, since, in the case of a difference of velocity between the upper and lower strata, the effective areas of the surfaces exposed to the two streams enter into the problem. In all positions the effective surface which a globe wholly immersed presents to the current is a great circle. The velocity attained by the connected globes is a *simple mean* of the velocities of the superficial and lower strata when the effective surfaces are *equal;* and when these surfaces are *unequal*, the *mean* by *weight*. If $x =$ velocity at surface, $y =$ volocity at lowest point; then with equal surfaces we obtain velocity of globes $= \frac{1}{2}(x + y)$. If the effective surfaces opposed to the drifts (portions of great circles) are unequal, and their areas be represented by a and b, we have the velocity of globes $= \frac{1}{a+b}(ax + by)$. This expression represents the immediate result obtained by the original manner of using the globes if the vessel be at anchor; but, in our modification, the result of our experiment is the difference between the motion of the free and that of the connected globes, or $x - \frac{1}{a+b}(ax + by)$. The extent of the wetted surface of the free globe will not affect the result, but it is convenient to have this globe of the same size as the others so as not to be greatly affected by winds.

If the paths of the surface and sub-currents do not lie in the same vertical plane, the connected globes take an intermediate course, with velocity $= \frac{1}{a+b}\sqrt{\{(a\,x \sin.\,\beta_1 + by \sin.\,\beta_2)^2 + (a\,x \cos.\,\beta_1 + by \cos.\,\beta_2)^2\}}$, and $tan\ \theta$ (angle of direction) $= \frac{a\,x \sin.\,\beta_1 + by \sin.\,\beta_2}{a\,x \cos.\,\beta_1 + by \cos.\,\beta_2}$ when β_1 and β_2 represent the respective angles of direction of the upper and lower drifts.

When observations are to be made at sea, where there is a great depth of water, a further modification of the apparatus is necessary. In place of the two connected globes in the foregoing description, a hempen line is used, (perhaps two inches in diameter,) terminating in a wooden pole above and a leaden cylinder below, the former serving to float the shaft, while the latter sinks and straightens the line, and the reel is transferred to the free globe. (See Fig. 3, Sketch No. 40.) The apparatus, thus modified, will serve to exhibit the difference between the

surface drift and the mean velocity of a stratum of water whose depth equals the length of the shaft immersed. If we know the surface velocity we may readily obtain the velocity of the lowest point reached, *if we suppose the change of velocity from point to point to be uniform*, by subtracting the surface rate from twice the mean velocity. This supposition is not always correct, and must be tested by the following experiment: The log-line having been unfastened, the pole is passed through a copper globe, and the line drawn up until the globe can be secured at a point which will occupy a middle position of the wetted surface on again letting the shaft sink as far as it may.—(See Fig. 4, Sketch No. 40.) Upon a new trial, if the velocity observed is still the same, we may conclude that our supposition is correct; if not, we may, by shifting the position of the globe again and again, making at each remove an observation and record, or by using simultaneously several such shafts, calculate approximately the conditions of the sub-currents and the curve at which our deep shaft hangs. The globes which we have used measure two feet in diameter.

Before closing this rapid sketch of our devices for obtaining the data required by your instructions, I would refer briefly to a new form given to a pile used in securing a tide-gauge at Fire island, and which, I think, possesses some peculiar advantages for use upon sandy coasts where there is a heavy sea. This pile is of oak, or other heavy and strong wood, and is so cut that the lower portion of it, for a space of six or eight feet, presents the appearance of a number of inverted frustrums of cones, placed one above another—the series terminating in a sharp and heavy shoeing. As a whole, it is required to have a greater weight than the sand and water it is intended to displace. On working this pile into the sand, by swaying it to and fro, in the usual manner, each cone, as it sinks, acts upon the sand *above* and *below*, as at once a lever and a wedge, giving to the whole a continual downward thrust. In the same way the waves, instead of tearing it up, cause it to work deeper and deeper, and thus the lateral oscillation of the sea is converted into vertical motion, and brought to our aid. Of course this downward tendency of the pile can be easily checked if too great for our purposes. As my description of this pile is not altogether clear, I annex a diagram, (Sketch No. 40,) which will require no explanation.

Very respectfully, yours,

HENRY MITCHELL,
Assistant Coast Survey.

Professor A. D. BACHE,
Superintendent Coast Survey.

APPENDIX No. 27.

Report to the Superintendent by Assistant L. F. Pourtales, in charge of the field and office work relating to tidal observations.

COAST SURVEY OFFICE, *October* 1, 1859.

SIR: I have the honor to submit the following report on the field and office work performed by the tidal party under my charge during the past year:

FIELD-WORK.—The permanent stations at which the tides are observed for a long period of years are the same as mentioned in former reports, viz: Boston, New York, Old Point Comfort, Va.; Charleston, S. C., and Fort Clinch, Fla., on the Atlantic coast; and San Diego, San

Francisco, and Astoria, on the Pacific coast. The following table will show the date at which the series of observations began at each of those stations, and the number of years over which it consequently extends up to this date.

Station.	Kind of gauge.	Date of beginning of series.	Length of series up to October 1, 1859.	
			years.	m'ths.
Boston	Staff	June 1, 1847	12	4
New York	S. R.	December 12, 1852	6	10
Old Point Comfort	Box	May 3, 1845, to August 31, 1852		
Old Point Comfort	S. R.	September 1, 1852	14	5
Charleston, (Castle Pinckney)	Box	December 20, 1850, to April 22, 1855		
Charleston, (Castle Pinckney)	S. R.	July 16, 1855, to December 10, 1856		
Charleston, (custom-house wharf)	S. R.	February 1, 1856	9	9
Fort Clinch	S. R.	February 20, 1856	3	7
San Diego	Staff	July 6, 1853, to September 20 1853		
San Diego	S. R.	September 22, 1853	6	3
San Francisco	S. R.	June 14, 1853	6	4
Astoria	S. R.	July 11, 1853	6	3

The stations have, during the past year, given generally good results. The station at Fort Clinch has, however, suffered an interruption by the sickness and subsequent sudden leaving of the observer, and the inexperience of the person he had left in charge. The stations on the Western Coast, under the supervision of Lieut. G. H. Elliot, U. S. Engineers, have continued to give very satisfactory results.

The temporary stations were not numerous. The tide-gauge at the Washington navy yard is still kept up. Owing to the frequent changes of the officers in the ordnance department of the yard, it was found more advantageous to have the gauge attended to by Mr. Walker, of this division of the office.

The stations mentioned in last year's report as having been established by Mr. Würdemann at Charlotte harbor, Egmont key, and Cedar keys, have, together with the one at Tortugas, afforded very satisfactory results. The series being extended over more than a year, the gauges will shortly be transferred to new stations at and to the westward of St. Mark's. Mr. Würdemann has suffered greatly from sickness superinduced by exposure, and was obliged to leave that section at the approach of warm weather, without detriment, however, to the observations, thanks to the careful training he had given to the observers. On his way north, Mr. Würdemann visited the tide-gauges at Fort Clinch, Charleston, and Old Point Comfort.

The self-registering tide-gauge established at Warrenton navy yard, Pensacola, Fla., by the kindness of S. T. Abert, esq., civil engineer of the yard, gives very good results, and will supply a useful link in the chain of stations which it is intended to establish successively along our shores on the Gulf of Mexico.

Good self-registering observations were obtained at Benicia, Cal., under the direction of the hydrographic party of Commander J. Alden, U. S. N., Assistant Coast Survey.

A list of the observations received during the year is herewith presented. It contains, as usual, only those which were made under the direction of this division of the office, and not those made by hydrographic parties for the reduction of their soundings.

List of tidal observations received during the year ending September 30, 1859.

Section.	Name of station.	Name of observer.	Kind of gauge.	Stations, permanent or temporary.	Time of occupation. From—	Time of occupation. To—	Total day .	Remarks.
I	Boston Dry Dock, Mass.	T. E. Ready	Staff	Permanent	Oct. 1, 1858	Sept. 30, 1859	365	
II	Governor's Island, N. Y.	R. T. Bassett	S. R	do	Oct. 1, 1858	Dec. 30, 1858	91	} Obs'ns made at Brooklyn during the cold weather.
	Do	do	do	do	April 7, 1859	Sept. 30, 1859	177	
	Brooklyn, N. Y	do	Box	do	Oct. 1, 1858	Sept. 30, 1859	365	Only day observations during the summer.
	Dobb's Ferry, N. Y	W. H. Roberts	Staff	Temporary	July 23, 1858	July 31, 1858	9	
	Verplank's Point, N. Y.	J. G. Rotche	do	do	July 22, 1858	Aug. 3, 1858	13	
	Do	do	do	do	Sept. 10, 1858	Sept. 14, 1858	5	
	Cold Spring, N. Y	do	do	do	Sept. 11, 1858	Sept. 14, 1858	4	
	Poughkeepsie, N. Y	do	do	do	July 22, 1858	Aug. 1, 1858	11	
	Tivoli, N. Y	G. R. Martin	do	do	July 22, 1858	Aug. 1, 1858	11	
	Stuyvesant, N. Y	D. B. Jenks	do	do	July 22, 1858	July 31, 1858	10	
	Castleton, N. Y	do	do	do	July 22, 1858	Aug. 2, 1858	12	
	Greenbush, N. Y	do	do	do	July 22, 1858	July 31, 1858	10	
III	Old Point Comfort, Va.	M. C. King	S. R.	Permanent	Oct. 1, 1858	Sept. 30, 1859	365	
	Wash. Navy Yard. D. C.	Off. Ordnance Dept.	do	Temporary	Oct. 1, 1858	Jan. 8, 1859	100	
	Do	S. Walker	do	do	Feb. 10, 1859	Sept. 30, 1859	232	
V	Charleston, S C	W. R. Herron	do	Permanent	Oct. 1, 1858	Sept. 30, 1859	365	
VI	Fort Clinch, Fla	F. A. Rebarer	do	do	Oct. 1, 1858	Dec. 14, 1858	21	Stopped from Oct. 16 to Dec. 9, obs'ver being sick.
	Do	J. A. Walker	do	do	Dec. 14, 1858	Sept. 30, 1859	261	
	Tortugas, Fla	H. Benners	do	Temporary	Aug. 1, 1858	Sept. 1, 1859	396	
	Charlotte Harbor, Fla	G. W. Maslin	do	do	Aug. 3, 1858	Aug. 2, 1859	365	
	Egmont Key, Fla	C. Keyser	do	do	Aug. 22, 1858	Aug. 31, 1859	375	
VII	Cedar Keys, Fla	A. Steele	do	do	Aug. 11, 1858	Sept. 1, 1859	386	
	Do	G. Crockett	Staff	do	Dec. 27, 1858	Jan. 6, 1859	11	
	Warrington Navy Yard, Fla.	S. T. Abert	S. R	do	Nov. 20, 1858	Aug. 18, 1859	266	
X	San Diego, Cal	A. Cassidy	do	Permanent	Aug. 1, 1858	July 31, 1859	365	
	Fort Point, Cal	H. E. Unrlandt	do	do	Aug. 1, 1858	July 31, 1859	365	
	Benicia, Cal	Louis Nelson	do	Temporary	June 25, 1858	Oct. 21, 1858	88	
XI	Astoria, Oregon	Louis Wilson	do	Permanent	Aug. 1, 1858	July 31, 1859	365	

OFFICE-WORK.—The following persons have been permanently employed during the year: R. S. Avery, S. Walker, J. Downes, M. Thomas, and S. D. Pendleton; and the following temporarily for longer or shorter periods during the intervals of their duties in the field or in other departments of the office: Lieut. J. P. Roy, U. S. A.; Sub-Assistant C. Fendall; James Gilliss, R. E. Evans, O. Hinrichs, J. Donegan, A. W. King, and T. C. Bowie.

Mr. Avery has continued the discussion of the Boston tidal observations. Having computed a set of co-efficients from a period of observations extending over nine years, he has compared the times of high water computed by means of them with the observed times for the whole period of twelve years over which the series extend. The differences between the computed and observed times came out generally quite small.

The readings of the sheets of the self-registering tide-gauges were made by Mr. Walker, who has also had charge of the correspondence with the observers, of the examination of the observations returned by them, and of the tide-gauge at the Washington navy yard. This combination of duties has been very useful, as by reading the sheets no defects in them could escape him, and the remedy could be pointed out more intelligibly from the experience gained in managing a tide-gauge himself.

The ordinary reductions of tidal observations were made chiefly by S. D. Pendleton, and part of the year by contract, by A. W. King; also, occasionally, by Lieut. J. P. Roy, and J.

Gilliss, R. E. Evans, O. Hinrichs, and T. C. Bowie. They thus keep but little behind the receipt of the observations. The whole sets of reductions of the permanent stations on the Western Coast were revised by Mr. Walker.

The graphical decompositions of the tides observed simultaneously at the four stations Cape Florida, Indian key, Key West, and Tortugas, have continued to be made and the results to be reduced and compared by Mr. Downes, with the assistance for part of the time of Messrs. Fendall and Evans. This discussion is now nearly completed, and some progress has also been made in the decomposition of the observations at the next stations—Tortugas, Charlotte harbor, Egmont key, and Cedar keys. The daily inequality was deduced from a part of the ordinary reductions of the above stations by Mr. Gilliss.

The meteorological observations made at the tidal stations of the Western Coast have continued to be tabulated by M.. Thomas, who has also read off some of the self-registering sheets from Florida, and plotted the result preparatory to decomposition, besides copying and miscellaneous work.

Very respectfully, your obedient servant,

L. F. POURTALES,

Assistant U. S. Coast Survey, in charge of Tidal Division.

Prof. A. D. BACHE, LL.D.,

Superintendent U. S. Coast Survey.

APPENDIX No. 28.

Circulars found in current bottles thrown from the surveying steamer Corwin in 1857 *and* 1859, *in the vicinity of the Florida reef.*

U. S. COAST SURVEY.

TO SHOW THE SET OF CURRENT.

This bottle was thrown overboard in the Gulf Stream.

Lat. 24° 21′ 00″ N. Date: Midnight, March 28, 1857.

Long. 81° 56′ 00″ W. Wind west.

From surveying steamer *Corwin.*

Lieut. Comd'g T. AUG. CRAVEN, *U. S. N.*

The finder will confer a favor by forwarding this paper to A. D. Bache, Superintendent U. S. Coast Survey, Washington, D. C.

Record below the date and place where found.

Found on the beach about twenty miles south of Cape Cañaveral light-house on the 1st of May, 1859.

MILLS O. BURNHAM,

Light-keeper, Cape Cañaveral, Fla.

Particulars of six other cards of the same form from surveying steamer Corwin.

When thrown over.	Latitude N.	Longitude W.	Direction of wind.	By whom returned.	Endorsements made by the finder.
	° ′ ″	° ′ ″			
May 2, 1859........	25 00 27	79 44 15	North; light.......	Mills O. Burnham....	Found June 2, 1859, about five miles south of Cape Cañaveral light-house.
Do.............	25 00 27	79 44 15	North; moderate..	......do.............	Found June 18, 1859, about four miles south of Cape Cañaveral light-house.
April 30, 1859.......	23 31 30.4	80 45 13.05	From W.NW.; light.	Pedro Antonio Ebora.	Found May 7, 1859, at Cruz del Padre, twenty-one miles N.NE. of Cardenas, north coast of Cuba.
Do.............	24 22 07	80 53 08	From south; light..	W. S. Harris.........	Found June 2, 1859, twenty and a half miles south of Cape Cañaveral light-house.
May 2, 1859........	25 01 11	79 45 13	....	......do.............	Found June 2, 1859, twenty miles south of Cape Cañaveral light-house.
Do.............	25 01 11	79 45 13	Northwest.........	......do.............	Found June 10, 1859, nine miles south of Cape Cañaveral light-house.

APPENDIX No. 29.

Extracts from a report by Lieut. Comg. C. M. Fauntleroy, U. S. N., Assistant in the Coast Survey, relative to commercial advantages afforded by the upper waters of Port Royal sound, S. C.

UNITED STATES SURVEYING SCHOONER VARINA,
Colleton river, S. C., May 21, 1859.

SIR: * * * The hydrographic work was commenced at Pinckney's island, connecting with the survey of Lieut. Comg. Maffitt, in 1855. That survey shows that the bar of the Chechessee river affords twenty feet at mean low water, with a mean rise and fall of 6.6 feet. The depth increases in passing upward, and vessels that enter Port Royal sound will find in the Colleton river at the Neck, and at its confluence with the Chechessee, a capacious, completely protected, and easily accessible anchorage, in from four to seven fathoms water.

* * * * * * * * * *

Colleton Neck, Foot Point, or Victoria Bluff, as it has been more recently called, is only eleven miles from the Charleston and Savannah railroad, and, by reason of the fact before stated, offers a very eligible site for purposes of trade and commerce. In the event of blockade of the southern coast by a naval power this point could be easily made a sure protection to the inland commerce passing between Charleston and Savannah.

The bluff is considerably higher than the adjacent island, and is said to be healthy. The approach from Broad river is used by steamers continually, and might be improved so as to enable vessels of fifteen feet draught to pass. At present I think it safe to say that but ten or twelve feet at mean low water can be carried through. So soon as I can obtain the requisite tidal observations the soundings will be reduced and a chart sent to the office.

Very respectfully, your obedient servant,

CHAS. M. FAUNTLEROY,
Lieut. Comg. U. S. N., Assistant Coast Survey.

Professor A. D. BACHE,
Superintendent Coast Survey.

APPENDIX No. 30.

Letter to the Secretary of the Treasury, reporting the completion of the survey of Sapelo sound, Ga., and communicating extracts from a report by Lieut. Comg. C. M. Fauntleroy, U. S. N., Assistant Coast Survey, relative to its commercial facilities as a harbor.

COAST SURVEY OFFICE, *May* 24, 1859.

SIR: I have the honor to report the completion of the field-work and hydrography requisite for a chart of Sapelo sound and river, including the bar and approaches, from a limit ten miles seaward of the entrance. The soundings in the vicinity of the bar were made by the party of Lieut. Comg. C. M. Fauntleroy, U. S. N., assistant Coast Survey, who closed the operations there at the end of April.

I append some remarks made in the report of that officer, bearing on the commercial advantages of Sapelo sound as a harbor, and suggestions in reference to buoys and beacons for aiding vessels to enter it:

"This harbor derives its importance commercially from its ease of access and from the good depth of water in its main approach. Sixteen feet at mean low water may be carried throughout to safe anchorage inside of the entrance. As a cut-off connecting with it affords a convenient and safe inland passage for traders bound south coastwise during the winter season, this entrance is preferred to the more difficult entrance at Doboy. While the soundings were in progress in March and April, more than fifty schooners and steamers (chiefly the former class) passed into Sapelo sound and through Mud river.

"At present the channel over the bar is marked by two buoys. The inner one ('No 3') should be at once removed and replaced at the extreme northeast point of the shoal designated as 'Consort shoal.'

"There is both a swash and a beach channel here, and vessels drawing from five to eight feet of water may enter the harbor against northwesters—a facility uncommon on our Atlantic seaboard.

"Upon a rough comparison (before plotting the soundings) with the survey made by Lieutenant Glynn, U. S. N., in 1841, there appears to have been little or no change since, either as to depth or in the direction of the main channel-way.

"Masters of vessels, if not well acquainted, avail themselves of daylight for entering at Sapelo. It would be of important service to the coasting trade if two small beacon lights were established, instead of the two beacons now on the point of St. Catharine's island, as such an arrangement would prevent confusion with the Doboy light. The schooner 'Blooming Youth,' lost off Sapelo entrance in March, could have made the harbor in safety with such guides as those now proposed."

Regarding the aids for navigation recommended by Lieut. Comg. Fauntleroy as of general interest to masters of vessels engaged in the coasting trade, I would respectfully request that a copy of this communication may be transmitted to the Light-house Board.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 31.

Extracts from reports made by Sub-Assistants F. W. Dorr and Charles Ferguson, describing the topographical and other features of Charlotte harbor, Florida.

BOSTON, *March* 29, 1859.

SIR: * * * The work of the season was resumed on the western half of Sanibel island at a point where its breadth is about two miles and a quarter. From thence the island runs in a W.NW. direction five miles and a half, and gradully narrows as it approaches Blind Pass. The inside shore is very irregular and broken by large lagoons, which connect with each other by narrow tortuous channels. On the outside a fine sloping beach, composed of sand and shells, is washed by the waters of the Gulf of Mexico. The interior of the island is open prairie, bearing only scattered clumps of palmettoes. Mangrove, buttonwood, &c., are found fringing the shores of the lagoons, and this growth occasionally attains a breadth of a quarter of a mile.

The entrance to Blind Pass, as the channel which separates Sanibel from Captiva island is called, is almost entirely blocked up from the inside by extensive shoals, which are dry, or nearly so, at ordinary low water. On the southern side of these shoals are eight small keys, called the Lawrence keys. They are scarcely anything more than clumps of mangrove. Blind Pass is merely a boat channel; for although the passage is deep in some places, the bars both on the inside and outside preclude the possibility of carrying through a vessel of any draught of water.

Captiva island overlaps Sanibel island at Blind Pass for a distance of a mile and a half, and from that opening stretches in a N.NW. direction upwards of ten miles to Captiva Pass. This island, or key proper, scarcely averages a quarter of a mile in width. I say the key proper, as two other keys of some size, completely separated from it, have hitherto been supposed to join it; all three being comprised under the name of Captiva island.

Captiva, like Sanibel island, has a regularly curving beach of sand and shells on the outside, while the inside shore is skirted with mangrove, and is very ragged. Extensive flats, too, make off eastward from most of the prominent points of land on the inside.

Captiva Pass, the opening between Captiva and La Costa islands, is about five hundred yards wide. Vessels drawing not more than five feet of water can pass through; yet the channel is somewhat intricate. * * * * * *

Yours, very respectfully,

F. W. DORR, *Sub-Assistant.*

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

WASHINGTON, D. C., *April* 8, 1859.

DEAR SIR: * * * * *Boca Grande*, the pass between La Costa and Gasparilla islands, is the proper entrance to Charlotte harbor. It contains at low tide fifteen feet of water, and inside the bay has three or four fathoms. Vessels can carry eighteen feet some fifteen or twenty miles beyond the northern extremity of Pine island.

La Costa island is similar in character to Captiva island, as described in the report of Sub-Assistant Dorr.

Pine island forms the eastern side of Charlotte harbor, or what may be more correctly termed the Charlotte harbor approach. It is about ten miles in length and three in width. A pine barren runs through the centre nearly its entire length, and its western shore is lined with a belt of keys and islands. Lagoons break the western side and run in towards the interior of Pine island.

This island is remarkable as having been a favorite burial place of the aborigines. There are several huge mounds on the keys along the shore. The largest are at "Brown's" station, a small fishing ranch on Pine island, (nearly opposite the middle of La Costa,) where some are found sixty and eighty feet high and four hundred yards in circumference. Here also may be seen the remains of a canal which has passed at a former period quite across the island. Its site is now so overgrown with mangrove, pine, and palmetto that the trace is barely discernible.

* * * * * * * * *

Very respectfully, yours,

CHARLES FERGUSON,
Sub-Assistant.

Prof. A. D. Bache,
Superintendent U. S. Coast Survey.

APPENDIX No. 32.

Extracts from the report of Assistant S. A. Gilbert, descriptive of the coast of Texas intervening between Matagorda bay and Corpus Christi.

Zanesville, O., *August* 23, 1859.

Sir: * * * * * * * * * *

Espiritu Santo bay is about fifteen miles long, northeast and southwest, by about five miles in width. It communicates with the Gulf of Mexico through two small bayous at the northeast end, and connects also with Matagorda bay at Pass Cavallo. Through one of the bayous (McHenry's) the State authorities of Texas have caused a channel to be opened affording a depth of four and a half feet at average high water, and the digging of a channel of ten feet from the bayou into Pass Cavallo, to form a harbor or dock for steamers and other sea-going vessels, has been undertaken by private enterprize. The town of Saluria is situated at the east end of this bayou. Throughout the bay there is an average depth of seven feet, the bottom being generally soft mud and shells, except in one locality, known as the "Middle Ground," which is sand, and a portion of which is usually bare at low water. The shores are low and marshy on all sides. Along the northwest shore is a range of marsh islands, approaching towards the cluster designated as the "First chain," which divides Espiritu Santo from San Antonio bay. Through these also the State has opened a channel to the depth of four and a half feet, but flats are forming rapidly at both ends, and constant attention will be required to keep it open.

San Antonio bay is of an irregular and somewhat triangular shape, the greatest length being, from north to south, about twenty miles, and the width ranging from four to eighteen miles.

It has no direct communication with the Gulf of Mexico, and is, therefore, but little affected by the Gulf tides. Frequently the water is made fresh by the discharge from the Guadalupe river, which enters at its northeast end, and it is almost always muddy. The average depth of the south half of the bay is about six and a half feet, with soft mud bottom, except in the vicinity of the oyster shell reefs, of which there are many. One of them, "Panther Point reef," extending through the middle of the bay, north and south, about fifteen miles, is awash in some places and in others has five feet of water over it. In approaching the mouths of the river, the water of the bay shallows, and the bottom becomes very soft, and is covered with eel-grass and other sea-weeds. The State, in the spring of 1858, opened a channel of four and a half feet from the southern mouth of the Guadalupe to a like depth in the bay, which was found at the distance of a mile, but it is now much obstructed by drift logs. Without the use of artificial means, the average depth of water into either mouth of the river would not be more than eighteen inches.

The shores of San Antonio bay are varied in character. Along its south and east sides are the low marshy shores of the islands, (Matagorda island and others,) which are the resort of immense numbers of water fowl. Thousands of swans, geese, brant, and ducks of several varieties, cover the waters and prairie of this region during January, February, and March; and in all seasons the pelican, cranes of perhaps every variety, the snipe, and other shore birds, are found in countless numbers. Oysters are plenty, and also redfish and trout, when the water is not too fresh.

Near the north end, on the east side of the bay, the prairie of Matagorda island comes to the shore in a bluff twenty feet high, along which (for several miles) are scattered clusters of oak and hackberry trees. This locality, known as "Long Motts," contains fifteen or twenty houses.

The northwest shore is the delta of the Guadalupe, a low alluvial formation, scarcely raised above the level of the adjacent waters, and covered with a dense growth of cane-grass, jungle, and forest trees. On the west shore the elevated prairie also comes to the bay in a bluff or bank of twenty feet, and is likewise dotted over with the houses of settlers, and with oak and hackberry trees. The soil is fertile, the range for stock excellent, and the locality is said to be very healthy. At one place on this side a singular range of sand hills, known as the "Sand Mounds," approaches the shore. The highest peak is about seventy-five feet above the bay. The mounds are covered with bushes, and the valleys between them filled with trees, so that, at a distance of five or six miles, the whole presents the appearance of a forest of live-oak or similar timber, forming a marked feature in that otherwise level prairie region. Deer, wolves, and wild turkeys are plenty, and rattlesnakes and other reptiles numerous. In the direction towards Lamar, a distance of about thirty miles, there is now but one dwelling, and hence the wild game has not been much disturbed.

Mission bay is a small, shallow sheet of water cut off from the head of San Antonio bay, on the east side, by the delta of the Guadalupe river, and having not over eighteen inches of water into or through it. A small bayou, entering on its east side, drains Green lake, which is a small sheet of fresh water lying some miles further up the delta.

Hines bay, on the west side of the delta, is of the same character, but is larger, being about three and a half miles in diameter and shaped like a horse-shoe. It is also deeper than Mission bay, affording about three feet of water to its head. On the north side is the swamp of the

delta, but on the south a prairie bluff twenty feet high bounds the shore, and here, within space of three miles, some twenty or thirty houses form what is called "Crescent Village."

San Antonio bay is divided from Mezquit bay by a chain of islands known as the "Second chain," and by an oyster shell reef, designated as "Ayre's reef," through which a four-feet channel has been opened by the State. The small islands composing the Second chain are mostly covered with lignum vitæ and mezquit bushes, from six to eight feet high, and in these the smaller varieties of crane have their building place. The bushes are covered with nests and thronged with cranes all spring and summer, there being no similar resort for a hundred miles either way along the coast.

Mezquit bay is about five miles long, northwest and southeast, and about three miles wide, with an average depth of four feet throughout, and soft muddy bottom. It has direct communication with the Gulf of Mexico through Cedar bayou, into the north end of which there is but one foot of water, through the bayou about ten feet, and at the Gulf outlet, or south end, about four and a half feet. Its length is three miles, and average width about a hundred and sixty yards. The oysters of this bay are noted as being the best on the coast. Fish are abundant, and to be had at all seasons of the year.

The shores of Mezquit bay are marshy, except on the northwest side, near which lie two islands, with oyster shell ridges, ranging from five to fifteen feet in height, and covered with chaparral. It is separated from Aransas bay by the cluster of islands called the "Third chain" and by two oyster shell reefs. Through these the State has opened a channel of four feet.

Aransas bay is about twenty miles long from N.NE. to S.SW., and of an average width of about six miles. About five miles from the north end lies an oyster shell reef, called "Long reef," which extends across the bay, from St. Joseph's island to Lamar. This is bare in several places, forming islands much subject to change in outline and extent by the action of the waves during the prevalence of the summer winds. There are several channels through the reef, two of which are nearly a quarter of a mile wide, with six feet water; and that is about the average depth of the bay north of the reef. South of Long reef the bay is open and free from obstructions, with an average depth of ten to twelve feet, and soft, muddy bottom, excepting near the shell reefs and shores. The beach is composed of hard sand, and the bottom, out to a depth of five feet, is of the same character, except in a locality about eight miles from Lamar, where it is rocky, a remarkable bed of natural concrete being developed there. At the bluff the formation is six feet in thickness above the surface of the water, and appears to extend about ten feet below it. I have no knowledge of any similar formation along the coast, except in the high prairie back of Copano bay, near the mouth of the Aransas river, the bed there being entirely above the level of the bay; and in Laguna Madre, about thirty miles southward of Corpus Christi bay, in which instance the formation is said to be wholly below the water level. The rock in question has been used in building walls and chimneys at St. Mary's. While in place it is soft and easily cut, but after exposure to the atmosphere it becomes as hard as ordinary limestone. The color is a dirty white, and the fracture irregular. From the point at which the rock occurs a sand-flat ranges northward along the northwest shore of the bay, covered to a depth of five or six feet with "turtle grass." Large numbers of green turtle are caught here, and shipped to New Orleans during the spring and summer. There are occasional beds of oysters throughout the bay, and an abundance of fish of all the varieties that inhabit the Gulf.

Aransas bay connects with the Gulf of Mexico through Aransas Pass, which is said to be subject to changes in depth at the bar and in the channel. During last winter and spring there was an average of more than eight and a half feet over the bar at low water, as we were informed by the pilot. At the close of the working season in June arrangements were in progress for running a line of steamers from the bay to New Orleans or Mobile. The communication with Corpus Christi bay is through a narrow and crooked channel between islands and mud flats for about five miles, called Corpus Christi bayou. Its natural depth is about four feet, but a channel to admit vessels drawing six feet has been opened by a private company.

The entrance to Copano bay, between Live Oak Point and Lamar, is over a mile in width. Lap reef, much of which is bare, lies at the west side of the entrance, but there is a channel nine feet deep leading through it into Copano bay. This entrance forms what is known as "Lamar harbor," a space of about six miles in area, over much of which there is a depth of twelve feet water, with soft bottom. The harbor is sheltered either by reefs that are nearly or quite bare, or by land, on all sides.

The shores of Aransas bay are low on the south and east. On the north a chain of small islands divides it from St. Charles bay; and on the northwest side stretches Live Oak peninsula, with its high sand bluffs and hills, some of which are fifty or sixty feet high, and covered with a scattered growth of live-oak and other trees, and an undergrowth of many kinds of bushes and vines. The Mustang grape, a native of the soil, and from which is made a very fine flavored wine, grows here in abundance. Fresh water is plenty, but the range for cattle on the peninsula is not good. There are at present but four families living on it, within an area of fifty square miles.

The town of Lamar lies between the outlets of St. Charles and Copano bays. *St. Charles bay* is about nine miles long north and south, by about a mile in average width. A narrow, crooked channel affords about two and a half feet of water into it, but after the main part of the bay is reached the depth increases to four, and in some places as much as eight feet. Cavasso creek, coming in about six miles up, on the west side, and Salt creek, at the head of the bay, are merely drains for the rain water which falls on the adjacent prairie. In the dry season their beds are filled with salt water from the bay. The shores of the bay are mostly marshy, but at many points the marsh is interrupted by prairie bluff of eight feet or more in height. Along the east side stands a body of wood known as "The Black Jacks." The soil there is sandy, and the general surface marked by numerous hills, as at the Sand Mounds, at Lamar, and on Live Oak peninsula, and by fresh water springs and ponds. In all other localities within my knowledge along the coast of Texas there is no fresh water below the surface except immediately along the Gulf shore, on sandy islands. In many other places I have dug, but always found the water salt, as in the Gulf.

Copano bay is about fifteen miles long from northeast to southwest, and about seven miles wide. It is divided nearly across the middle by an oyster shell reef called "Copano reef," around the south end of which passes a channel of nine feet at an average stage of water, and that depth may be carried to the head of the bay during the ordinary summer tides. There are other obstructions to navigation throughout the bay to be developed in the progress of the hydrographic work. Copano creek empties into the northeast end of the bay; Mission river through Refugio Mission bay, on the northwest side; and Aransas river at the western angle of the bay. All these are inconsiderable streams, there being no more than one foot of water leading into them from the bay. The shores are mostly high, and along the north and west

shores, except near Mission or Refugio bay, the prairie fronts the water-line as a bluff, rising from fifteen to thirty feet high. That portion between the Aransas and Mission rivers is wooded; the rest is prairie, with occasional spots of timber in view. The southeast shore of Copano bay is formed by Live Oak peninsula, and is marshy along the water-line, but a short distance back rise the high sand ridges and prairie that characterize these localities. The two towns, Copano and St. Mary's, the former one of the earliest settlements made in this part of Texas, lie on the northwest side of the bay, and are still but small villages.

The land seems to be valued only for grazing, although sea-island cotton and corn have been successfully cultivated in small tracts.

Puerto bay is a small arm extending from the southwest corner of Copano bay, about five miles in a southwest direction. The entrance to it is shallow, and the depth inside is only four or five feet. The shores are generally low and marshy. A small creek, which is merely a surface drain, discharges at the head of the bay.

Refugio bay is about three miles across in either direction, and is very shallow.

The climate of this part of the coast of Texas is generally considered very healthy, and the quarter is frequently resorted to by persons who have become sickly from residence on the alluvial bottoms along the rivers. The temperature during January and February of the past winter averaged about 56° Fahrenheit, the lowest being 28° for a few hours only towards the close of a "norther," which lasted three days. During March and April it was about 70°; and for May and June, which are said to be the hottest months of the year, the average was 84°. The highest temperature recorded was 91° on the 27th of May.

There is almost a constant breeze from the Gulf day and night after the middle of April.

* * * * * * *

Respectfully, your obedient servant,

SAM'L A. GILBERT,
Assistant U. S. Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 33.

Tables for projecting maps of large extent, arranged by J. E. Hilgard, Assistant U. S. C. S.

These tables are based upon a polyconic development of the earth's surface, which supposes each parallel of latitude to be represented on a plane by the development of a cone having the parallel for its base and its vertex in the point where a tangent to the parallel intersects the earth's axis. The degrees on the parallel preserve their true length, and the general distortion of area is less than in any other geometrical mode of representing a given portion of the earth's surface.

Denoting by a the equatorial radius of the spheroid, e the eccentricity, then the normal to any point on the parallel of latitude L, produced to the minor axis, is

$$N = \frac{a}{(1 - e^2 \sin^2 L)^{\frac{1}{2}}}.$$

The radius of curvature in the meridian is

$$R_m = \frac{a(1-e^2)}{(1-e^2 \sin^2 L)^{\frac{3}{2}}}$$

The radius of the parallel, $R_p = N \cos L$.

The radius of the developed parallel, or the side of the tangent cone, $r = N \cot L$.

Designating by n any arc of the parallel, or difference of longitude to be developed, and by θ the corresponding angle subtended by the developed parallel at the vertex of the cone, then the length of the given arc will be $n\, R_p = n\, N \cos L$, and also

$$\theta r = \theta N \cot L \qquad \text{whence } \theta = n \sin L.$$

To determine the rectangular co-ordinates x and y for projecting from the middle meridian the points of intersection of the meridians and parallels, we have simply, the developed parallels being arcs of circles,

$$x = r \sin \theta,\ y = r \text{ versin } \theta.$$

Table I gives the length, in metres, of one degree of latitude and longitude for each degree of latitude from 0° to 54°; also the radii of the developed parallels which may be used to describe the parallels by means of beam compasses when the scale permits. It also gives the values of θ for 10° of longitude, by means of which the tables may readily be extended.

Table II gives the co-ordinates for thirty degrees of longitude on each parallel from latitude 1° to 54°. The numbers correspond to the actual dimensions of the earth in metres, and are to be divided by the proper number for any desired scale.

In order to project a map by the aid of these tables draw a straight line as middle meridian of the map, on which space off the required degrees of latitude by the values given in Table I. Through the points so marked construct lines perpendicular to the meridian and parallel with each other, which will be tangents to the parallels of latitude at their intersections with the middle meridian.

On these tangents lay off from the middle meridian, for each required longitude, the corresponding x from the tables, and off-set y perpendicular to it, towards the pole. Through the points so found draw continuous curves for the parallels and meridians.

The tables are based on the following constants, being Bessel's latest, and those used in the Coast Survey:

Equatorial radius of the earth·······	$a = 6\ 377397$ metres,	log. $= 6.80464346$
Polar radii of the earth ············	$b = 6\ 356079$ "	" $= 6.80318928$
Square of the eccentricity $\frac{a^2-b^2}{a^2}$····	$e^2 = 0{\cdot}00667437$ "	" $= 7.8244104$

TABLE I.

Length in metres of one degree of latitude and longitude, values of the corresponding radii of the developed parallel, and angles at each pole for ten degrees of longitude.

Lat.	1° of latitude.	1° of longitude.	Radius of parallel.	θ for 10° of long.
°	*Metres.*	*Metres.*	*Metres.*	° ′ ″
0	110 563.7	111 306.6	Infinite.	0 00 00.0
1	110 564.0	111 289.7	365 361 200	0 10 28.3
2	110 565.0	111 239.2	182 625 500	0 20 56.4
3	110 566.7	111 155.0	121 689 100	0 31 24.1
4	110 569.0	111 037.3	91 202 500	0 41 51.2
5	110 572.0	110 885.8	72 895 830	0 52 17.6
6	110 575.8	110 700.9	60 679 100	1 02 43.0
7	110 580.1	110 482.4	51 942 300	1 13 07.3
8	110 585.1	110 230.5	45 380 470	1 23 30.2
9	110 590.8	109 945.2	40 268 590	1 33 51.6
10	110 597.0	109 626.6	36 171 660	1 44 11.3
11	110 604.0	109 274.9	32 812 850	1 54 29.1
12	110 611.6	108 890.0	30 007 630	2 04 44.8
13	110 619.7	108 472.1	27 628 210	2 14 58.2
14	110 628.5	108 021.4	25 583 340	2 25 09.2
15	110 637.9	107 538.0	23 806 090	2 35 17.5
16	110 647.8	107 022.0	22 246 270	2 45 22.9
17	110 658.4	106 473.4	20 865 480	2 55 25.4
18	110 669.4	105 892.6	19 633 870	3 05 24.6
19	110 681.1	105 279.7	18 527 860	3 15 20.5
20	110 693.3	104 634.8	17 528 600	3 25 12.7
21	110 706.0	103 958.2	16 620 820	3 35 01.3
22	110 719.2	103 250.0	15 792 110	3 44 45.8
23	110 732.9	102 510.5	15 031 865	3 54 26.3
24	110 747.1	101 739.8	14 331 780	4 04 02.5
25	110 761.7	100 938.2	13 684 530	4 13 34.3
26	110 776.7	100 105.9	13 083 990	4 23 01.4
27	110 792.2	99 243.2	12 524 960	4 32 23.7
28	110 808.1	98 350.2	12 002 960	4 41 41.0
29	110 824.4	97 427.4	11 524 770	4 50 53.1
30	110 841.0	96 474.8	11 055 200	5 00 00.0
31	110 858.0	95 492.9	10 623 179	5 09 01.4
32	110 875.2	94 481.9	10 215 570	5 17 57.1
33	110 892.8	93 442.1	9 830 067	5 26 47.0
34	110 910.7	92 373.8	9 464 760	5 35 31.0
35	110 928.8	91 277.3	9 117 882	5 44 08.8
36	110 947.2	90 152.9	8 787 972	5 52 40.3
37	110 965.8	89 001.0	8 473 340	6 01 05.3
38	110 984.6	87 821.9	8 173 042	6 09 23.8
39	111 003.5	86 616.0	7 885 875	6 17 35.5
40	111 022.6	85 383.6	7 610 788	6 25 40.4
41	111 041.8	84 125.1	7 346 915	6 33 38.1
42	111 061.1	82 840.8	7 093 423	6 41 28.7

TABLE I.

Length in metres of one degree of latitude and longitude, &c.—Continued.

Lat.	1° of latitude.	1° of longitude.	Radius of parallel.	θ for 10° of long.
°	*Metres.*	*Metres.*	*Metres.*	° ′ ″
43	111 080.5	81 531.1	6 849 560	6 49 11.9
44	111 100.0	80 196.5	6 614 648	6 56 47.7
45	111 119.4	78 837.3	6 388 064	7 04 15.8
46	111 138.9	77 453.9	6 169 244	7 11 36.2
47	111 158.4	76 046.8	5 957 663	7 18 48.7
48	111 177.8	74 616.3	5 752 845	7 25 53.2
49	111 197.2	73 162.9	5 554 355	7 32 49.6
50	111 216.4	71 687.0	5 361 781	7 39 37.6
51	111 235.6	70 189.1	5 174 752	7 46 17.3
52	111 254.6	68 669.6	4 992 925	7 52 48.4
53	111 273.4	67 129.0	4 815 973	7 59 10.9
54	111 292.1	65 567.7	4 643 603	8 05 24.6

TABLE II.

Co-ordinates of curvature.

Longitude.	Latitude 1°.		Latitude 2°.	
	x.	y.	x.	y.
1°	111290	17	111239	34
2	222580	68	222478	135
3	333869	153	333717	305
4	445149	271	444956	542
5	556448	424	556196	847
6	667738	610	667434	1220
7	779028	829	778672	1660
8	890317	1085	889910	2168
9	1001606	1373	1001148	2744
10	1112895	1695	1112386	3388
11	1224185	2051	1223622	4099
12	1335474	2441	1334859	4878
13	1446762	2864	1446094	5725
14	1558052	3322	1557330	6640
15	1669340	3814	1668565	7623
16	1780628	4339	1779799	8673
17	1891917	4898	1891033	9791
18	2003205	5492	2002266	10971
19	2114493	6119	2113498	12230
20	2225781	6780	2224729	13551
21	2337068	7475	2335960	14940
22	2448356	8204	2447189	16397
23	2559643	8966	2558419	17921
24	2670930	9763	2669646	19514
25	2782216	10593	2780873	21174
26	2893503	11458	2892099	22901
27	3004789	12356	3003323	24697
28	3116075	13388	3114547	26560
29	3227360	14254	3225770	28492
30	3338645	15254	3336991	30490

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 3°.		Latitude 4°.	
	x.	*y*.	*x*.	*y*.
1°	111155	51	111037	68
2	222310	203	222074	270
3	333465	457	333111	608
4	444619	812	444149	1081
5	555774	1269	555183	1690
6	666927	1828	666218	2433
7	778080	2488	777251	3312
8	889232	3249	888284	4326
9	1000384	4112	999315	5475
10	1111535	5077	1110345	6759
11	1222685	6143	1221373	8179
12	1333834	7310	1332400	9733
13	1444982	8579	1443424	11423
14	1556128	9950	1554446	13248
15	1667273	11422	1665467	15208
16	1778417	12996	1776483	17303
17	1889560	14671	1887498	19534
18	2000701	16448	1998510	21899
19	2111840	18326	2109520	24400
20	2222977	20306	2220526	27036
21	2334113	22388	2331528	29807
22	2445246	24570	2442527	32713
23	2556378	26854	2553523	35754
24	2667508	29240	2664515	38931
25	2778635	31728	2775502	42242
26	2889760	34316	2886486	45689
27	3000883	37007	2997466	49271
28	3112002	39799	3108441	52988
29	3223120	42692	3219411	56839
30	3334234	45687	3330377	60827

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 5°.		Latitude 6°.	
	x.	y.	x.	y.
1°	110886	84	110701	101
2	221771	337	221401	404
3	332656	759	332101	909
4	443541	1349	442800	1616
5	554424	2108	553497	2524
6	665306	3036	664192	3635
7	776186	4132	774885	4948
8	887065	5397	885576	6463
9	997941	6831	996263	8179
10	1108815	8433	1106947	10098
11	1219687	10205	1217628	12218
12	1330556	12144	1328304	14541
13	1441422	14253	1438976	17065
14	1552284	16529	1549644	19791
15	1663144	18975	1660306	22719
16	1773998	21589	1770963	25849
17	1884849	24372	1881614	29181
18	1995696	27323	1992258	32714
19	2106537	30444	2102896	36450
20	2217375	33732	2213529	40386
21	2328206	37190	2324152	44527
22	2439034	40815	2434768	48868
23	2549856	44610	2545377	53411
24	2660670	48573	2655974	58155
25	2771479	52704	2766566	63101
26	2882284	57005	2877148	68250
27	2993080	61473	2987719	73599
28	3103868	66111	3098282	79151
29	3214646	70916	3208828	84904
30	3325421	75891	3319368	90859

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 7°.		Latitude 8°.	
	x.	*y.*	*x.*	*y.*
1°	110482	118	110230	134
2	220964	470	220460	536
3	331446	1057	330689	1205
4	441924	1880	440914	2142
5	552402	2937	551139	3347
6	662876	4230	661359	4817
7	773348	5757	771576	6560
8	883817	7520	881789	8568
9	994281	9517	991996	10844
10	1104741	11751	1102196	13388
11	1215196	14216	1212391	16198
12	1325644	16919	1322578	19277
13	1436087	19856	1432757	22623
14	1546525	23028	1542929	26237
15	1656954	26435	1653090	30119
16	1767377	30077	1763243	34268
17	1877793	33954	1873387	38685
18	1988199	38065	1983515	43369
19	2098596	42412	2093635	48321
20	2208983	46992	2203742	53540
21	2319360	51809	2313835	59027
22	2429728	56859	2423920	64781
23	2540085	62145	2533983	70802
24	2650428	67665	2644033	77091
25	2760760	73420	2754069	83647
26	2871080	79409	2864087	90470
27	2981388	85633	2974089	97561
28	3091680	92092	3084076	104918
29	3201959	98786	3194041	112544
30	3312233	105713	3303988	120435

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 9°.		Latitude 10°.	
	x.	*y*.	*x*.	*y*.
1°	109945	150	109626	166
2	219889	400	219252	664
3	329832	1351	328875	1495
4	439771	2401	438495	2658
5	549709	3752	548112	4153
6	659642	5403	657723	5980
7	769569	7354	767329	8140
8	879492	9605	876927	10631
9	986517	12157	986517	13455
10	1096098	15009	1096098	16612
11	1209215	18160	1205669	20099
12	1319106	21611	1315229	23919
13	1428987	25363	1424777	28071
14	1538857	29414	1534311	32555
15	1648716	33766	1643833	37372
16	1758564	38417	1753340	42519
17	1868397	43369	1862826	47999
18	1978215	48620	1972299	53811
19	2088022	54171	2081754	59954
20	2197811	60022	2191188	66429
21	2307582	66172	2300603	73236
22	2417340	72622	2409997	80374
23	2527077	79372	2519369	87844
24	2636797	86422	2628718	95646
25	2746496	93771	2738043	103778
26	2856174	101419	2847344	112242
27	2965832	109367	2956614	121037
28	3075467	117614	3065860	130163
29	3185080	126161	3175080	139621
30	3294668	135007	3284269	149409

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 11°.		Latitude 12°.	
	x.	*y*.	*x*.	*y*.
1°	109275	182	108890	198
2	218548	728	217778	790
3	327819	1638	326663	1778
4	437086	2911	435545	3161
5	546349	4549	544420	4939
6	655605	6550	653288	7112
7	764855	8914	762148	9680
8	874095	11644	870997	12643
9	983326	14737	979836	16001
10	1092546	18195	1088661	19755
11	1201754	22014	1197471	23902
12	1310948	26198	1306266	28445
13	1420129	30745	1415045	33383
14	1529293	35657	1523804	38715
15	1638441	40932	1632543	44442
16	1747571	46569	1741261	50562
17	1856678	52571	1849955	57079
18	1965769	58936	1958626	63989
19	2074836	65664	2067270	71293
20	2183880	72754	2175886	78991
21	2292900	80210	2284476	87085
22	2401894	88027	2393035	95571
23	2510864	96208	2501563	104453
24	2619804	104752	2610057	113727
25	2728715	113657	2718517	123395
26	2837593	122925	2826940	133456
27	2946444	132556	2935326	143911
28	3055262	142550	3043675	154759
29	3164047	152906	3151984	166000
30	3272794	163624	3260251	177635

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 13°.		Latitude 14°.	
	x.	*y.*	*x.*	*y.*
1°	108472	213	108021	228
2	216942	852	216040	913
3	325409	1916	324055	2052
4	433871	3407	432065	3649
5	542326	5323	540067	5701
6	650773	7665	648059	8209
7	759209	10433	756040	11174
8	867634	13627	864007	14594
9	976047	17246	971959	18470
10	1084443	21291	1077893	22802
11	1192822	25761	1187808	27589
12	1301185	30657	1295703	32832
13	1409526	35979	1403574	38531
14	1517846	41725	1511419	44685
15	1626141	47897	1619238	51294
16	1734413	54494	1727028	58359
17	1842658	61516	1834787	65878
18	1950873	68963	1942514	73853
19	2059060	76835	2050206	82282
20	2167214	85131	2157862	91166
21	2275334	93852	2265478	100504
22	2383421	102998	2373055	110297
23	2491470	112568	2480589	120554
24	2599481	122562	2588079	131245
25	2707451	132980	2695523	142400
26	2815380	143821	2802919	154008
27	2923265	155086	2910264	166069
28	3031106	166775	3017558	178584
29	3138899	178888	3124798	191551
30	3246644	191423	3231982	204972

TABLE II.

Co-ordinates of curvature—Continued.

Longitude	Latitude 15°		Latitude 16°.	
	x.	y.	x.	y.
1°	107538	243	107022	257
2	215073	972	214041	1030
3	322604	2186	321055	2317
4	430128	3886	428061	4119
5	537644	6072	535058	6435
6	645148	8743	642042	9267
7	752641	11901	749012	12613
8	860116	15543	855963	16473
9	967575	19671	962896	20849
10	1075013	24285	1069806	25738
11	1182430	29383	1176691	31142
12	1289823	34967	1283549	37059
13	1397190	41036	1390377	43491
14	1504527	47590	1497173	50437
15	1611835	54629	1603935	57896
16	1719109	62152	1710659	65869
17	1826348	70160	1817344	74355
18	1933550	78652	1923987	83355
19	2040712	87629	2030584	92867
20	2147834	97089	2137136	102892
21	2254911	107033	2243639	113430
22	2361942	117461	2350089	124480
23	2468925	128372	2456484	136041
24	2575858	139766	2562823	148115
25	2682738	151643	2669102	160698
26	2789563	164003	2775319	173795
27	2896332	176846	2881473	187403
28	3003041	190170	2987559	201520
29	3109688	203976	3093577	216147
30	3216273	218265	3199523	231285

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 17°.		Latitude 18°.	
	x.	y.	x	y.
1°	106473	272	105892	286
2	212944	1087	211781	1142
3	319468	2445	317664	2570
4	425864	4346	423538	4569
5	532309	6791	529399	7139
6	638741	9779	635245	10279
7	745155	13310	741072	13991
8	851551	17384	846879	18273
9	957924	22001	952660	23126
10	1064272	27160	1058413	28549
11	1170592	32862	1164136	34542
12	1276882	39107	1269825	41106
13	1383139	45893	1375477	48239
14	1489360	53222	1481089	55943
15	1595541	61093	1586657	64216
16	1701682	69506	1692181	73057
17	1807778	78460	1797654	82469
18	1913827	87955	1903075	92448
19	2019826	97992	2008441	102997
20	2125773	108569	2113748	114113
21	2231664	119687	2218993	125797
22	2337498	131345	2324175	138048
23	2443270	143543	2429288	150867
24	2548979	156280	2534332	164252
25	2654621	169556	2639301	178204
26	2760194	183372	2744194	192722
27	2865695	197726	2849006	207804
28	2971122	212619	2953736	223453
29	3076471	228048	3058380	239666
30	3181741	244016	3162935	256443

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 19°.		Latitude 20°.	
	x.	*y*.	*x*.	*y*.
1°	105279	299	104634	312
2	210554	1196	209264	1249
3	315824	2692	313888	2811
4	421083	4786	418500	4997
5	526328	7478	523096	7807
6	631556	10767	627674	11242
7	736764	14655	732230	15301
8	841948	19140	836760	19984
9	947105	24224	941260	25290
10	1052231	29904	1045727	31221
11	1157323	36182	1150156	37775
12	1262378	43056	1254544	44952
13	1367393	50528	1358887	52755
14	1472362	58595	1463182	61176
15	1577285	67259	1567426	70221
16	1682156	76520	1671612	79889
17	1786973	86376	1775740	90178
18	1891733	96828	1879804	101089
19	1996431	107875	1983801	112620
20	2101066	119516	2087728	124772
21	2205630	131752	2191581	137545
22	2310126	144582	2295355	150937
23	2414545	158005	2399047	164949
24	2518888	172022	2502653	179579
25	2623149	186631	2606172	194827
26	2727326	201833	2709596	210693
27	2831414	217625	2812925	227176
28	2935410	234009	2916152	244275
29	3039312	250985	3019276	261991
30	3143116	268550	3122293	280322

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 21°.		Latitude 22°.	
	x.	*y*	*x*.	*y*.
1°	103958	325	103249	337
2	207911	1300	206494	1350
3	311856	2926	309730	3038
4	415790	5201	412953	5400
5	519706	8127	516158	8437
6	623603	11703	619341	12149
7	727475	15928	722498	16536
8	831319	20803	825623	21597
9	935130	26327	928714	27332
10	1038905	32501	1031765	33740
11	1142639	39323	1134771	40823
12	1246327	46794	1237729	48579
13	1349968	54915	1340634	57008
14	1453556	63682	1443482	66110
15	1557087	73097	1546268	75883
16	1660556	83160	1648989	86329
17	1763962	93869	1751638	97446
18	1867297	105226	1854214	109233
19	1970560	117228	1956708	121695
20	2073746	129876	2059120	134820
21	2176855	143169	2161446	148617
22	2279871	157107	2263676	163083
23	2382802	171689	2365815	178216
24	2485639	186914	2467844	194019
25	2588378	202782	2569772	210487
26	2691017	219294	2671591	227621
27	2793550	236445	2773294	245421
28	2895973	254239	2874881	263885
29	2998285	272672	2976343	283013
30	3100478	291745	3077677	302805

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 23°.		Latitude 24°.	
	x.	*y*.	*x*.	*y*.
1°	102510	348	101737	361
2	205014	1398	203472	1444
3	307510	3146	305196	3250
4	409991	5592	406905	5777
5	512453	8737	508592	9027
6	614893	12581	610254	12999
7	717301	17124	711885	17691
8	819677	22365	813481	23106
9	922016	28304	915036	29241
10	1024310	34938	1016543	36097
11	1126558	42274	1118003	43673
12	1228753	50305	1219404	51970
13	1330892	59033	1320740	60986
14	1432968	68457	1422013	70721
15	1534977	78577	1523217	81175
16	1636915	89393	1624339	92347
17	1738777	100903	1725381	104237
18	1840559	113108	1826337	116844
19	1942254	126006	1927200	130166
20	2043860	139598	2027967	144205
21	2145370	153882	2128631	158959
22	2246779	168859	2229188	174431
23	2348086	184526	2329632	190608
24	2449282	200885	2429959	207503
25	2550365	217932	2530164	225108
26	2651329	235669	2630241	243425
27	2752169	254094	2730186	262452
28	2852883	273205	2829993	282187
29	2953462	293004	2929657	302631
30	3053906	313488	3029174	323781

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 25°.		Latitude 26°.	
	x.	y.	x.	y.
1°	100938	372	100105	383
2	201869	1489	200204	1532
3	302790	3350	300291	3446
4	403694	5956	400361	6127
5	504577	9305	500407	9573
6	605432	13399	600424	13784
7	706253	18237	700406	18760
8	807037	23818	800347	24501
9	907777	30142	900241	31007
10	1008467	37209	1000083	38277
11	1109102	45019	1099866	46310
12	1209677	53571	1199583	55107
13	1310187	62864	1299232	64666
14	1410624	72899	1398804	74988
15	1510986	83673	1498296	86070
16	1611266	95189	1597697	97914
17	1711456	107443	1697006	110518
18	1811555	120436	1796215	123882
19	1911554	134168	1895320	138004
20	2011450	148636	1994313	152884
21	2111235	163840	2093191	168521
22	2210908	179781	2191946	184914
23	2310458	196456	2290571	202061
24	2409884	213865	2389063	219963
25	2509178	232007	2487415	238619
26	2608336	250880	2585622	258026
27	2707352	270485	2683677	278184
28	2806220	290819	2781575	299092
29	2904936	311882	2879310	320749
30	3003493	333672	2976877	343150

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 27°.		Latitude 28°.	
	x.	y.	x.	y.
1°	99242	393	98349	403
2	198478	1573	196692	1612
3	297702	3538	295021	3626
4	396907	6290	393330	6446
5	496086	9828	491614	10072
6	595235	14152	589864	14503
7	694346	19260	688074	19738
8	793414	25155	786238	25778
9	892431	31835	884350	32623
10	991392	39298	982402	40271
11	1090293	47545	1080388	48722
12	1189124	56576	1178302	57976
13	1287881	66389	1276136	68031
14	1386556	76985	1373886	78888
15	1485145	88362	1471542	90546
16	1583640	100520	1569100	103003
17	1682036	113458	1666552	116259
18	1780326	127175	1763893	130313
19	1878505	141672	1861115	145165
20	1976565	156944	1958212	160812
21	2074502	172994	2055178	177255
22	2172308	189819	2152005	194492
23	2269978	207419	2248689	212521
24	2367505	225791	2345221	231342
25	2464884	244937	2441596	250953
26	2562108	264853	2537807	271354
27	2659172	285539	2633848	292541
28	2756067	306993	2729711	314516
29	2852791	329214	2825392	337275
30	2949335	352201	2920883	360817

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 29°.		Latitude 30°.	
	x.	*y.*	*x*	*y.*
1°	97426	412	96474	421
2	194845	1649	192940	1684
3	292250	3709	289391	3788
4	389635	6594	385821	6735
5	486991	10303	482221	10522
6	584313	14836	578585	15151
7	681593	20192	674904	20620
8	778824	26370	771172	26930
9	875999	33372	867381	34080
10	973111	41194	963524	42068
11	1070153	49839	1059594	50896
12	1167120	59305	1155583	60562
13	1264003	69590	1251484	71064
14	1360795	80695	1347290	82404
15	1457490	92619	1442994	94579
16	1554080	105360	1538587	107588
17	1650559	118918	1634063	121432
18	1746920	133292	1729415	136108
19	1843156	148481	1824635	151615
20	1939260	164484	1919715	167953
21	2035225	181300	2014650	185120
22	2131044	198925	2109432	203115
23	2226710	217362	2204053	221936
24	2322218	236608	2298506	241583
25	2417558	256661	2392784	262052
26	2512727	277520	2486879	283345
27	2607715	299183	2580786	305456
28	2702516	321649	2674496	328387
29	2797124	344918	2768001	352134
30	2891531	368985	2861297	376697

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 31°.		Latitude 32°.	
	x.	*y.*	*x.*	*y.*
1°	95491	429	94480	437
2	190975	1717	188953	1748
3	286444	3862	283410	3932
4	381889	6866	377842	6990
5	477304	10728	472241	10921
6	572680	15447	566601	15725
7	668010	21024	660911	21402
8	763285	27457	755166	27950
9	858499	34747	849355	35370
10	953644	42891	943472	43661
11	1048712	51891	1037509	52822
12	1143694	61744	1131456	62853
13	1238584	72452	1225308	73751
14	1333375	84012	1319054	85517
15	1428057	96423	1412687	98150
16	1522625	109685	1506199	111648
17	1617069	123797	1599583	126011
18	1711382	138757	1692829	141237
19	1805557	154564	1785932	157324
20	1899587	171217	1878880	174272
21	1993463	188715	1971669	192078
22	2087177	207056	2064289	210742
23	2180723	226238	2156733	230263
24	2274093	246261	2248991	250637
25	2367279	267122	2341058	271863
26	2460273	288819	2432923	293940
27	2553070	311352	2524579	316866
28	2645660	334719	2616020	340638
29	2738036	358916	2707241	365256
30	2830192	383943	2798228	390715

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 33°.		Latitude 34°.	
	x.	*y.*	*x.*	*y.*
1°	93441	444	92373	451
2	186873	1776	184736	1803
3	280288	3997	277082	4057
4	373678	7105	369401	7211
5	467034	11101	461685	11267
6	560349	15984	553926	16223
7	653612	21754	646113	22079
8	746817	28410	738240	28835
9	839954	35952	830295	36488
10	933014	44378	922272	45041
11	1025991	53689	1014160	54491
12	1118875	63884	1105953	64837
13	1211658	74960	1197640	76079
14	1304331	86919	1289213	88214
15	1396887	99757	1380663	101243
16	1489317	113475	1471982	115163
17	1581611	128071	1563160	129975
18	1673763	143544	1654189	145675
19	1765763	159893	1745061	162263
20	1857605	177113	1835766	179738
21	1949278	195206	1926297	198096
22	2040775	214171	2016644	217337
23	2132087	234004	2106800	237459
24	2223208	254704	2196754	258460
25	2314126	276270	2286499	280338
26	2404836	298699	2376026	303091
27	2495329	321989	2465328	326717
28	2585597	346138	2554394	351212
29	2675630	371144	2643217	376576
30	2765423	397009	2731788	402806

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 35°.		Latitude 36°.	
	x.	y.	x.	y.
1°	91276	457	90151	462
2	182542	1827	180293	1850
3	273791	4112	270416	4161
4	365011	7309	360510	7398
5	456196	11419	450567	11558
6	547334	16443	540576	16642
7	638418	22378	630528	22649
8	729438	29225	720414	29579
9	820384	36982	810224	37430
10	911249	45650	899949	46202
11	1002022	55226	989579	55895
12	1092695	65711	1079104	66506
13	1183258	77104	1168517	78035
14	1273703	89402	1257806	90480
15	1364019	102605	1346963	103842
16	1454200	116711	1435979	118117
17	1544234	131720	1524842	133304
18	1634114	147628	1613546	149402
19	1723830	164437	1702080	166409
20	1813373	182142	1790434	184324
21	1902735	200741	1878600	203144
22	1991905	220237	1966569	222868
23	2080877	240623	2054330	243492
24	2169640	261899	2141876	265017
25	2258185	284062	2229196	287438
26	2346503	307110	2316281	310754
27	2434588	331042	2403123	334961
28	2522428	355854	2489711	360059
29	2610014	381544	2576038	386043
30	2697341	408110	2662093	412912

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 37°.		Latitude 38°.	
	x.	*y.*	*x.*	*y.*
1°	88999	467	87820	472
2	177989	1869	175630	1887
3	266959	4206	263420	4246
4	355899	7477	351180	7548
5	444800	11681	438899	11793
6	533653	16821	526567	16980
7	622446	22893	614174	23109
8	711171	29897	701710	30179
9	799817	37833	789166	38189
10	888374	46699	876530	47138
11	976834	56495	963793	57026
12	1065184	67219	1050945	67850
13	1153421	78870	1137976	79611
14	1241529	91449	1224875	92306
15	1329499	104952	1311633	105934
16	1417322	119377	1398239	120493
17	1504990	134725	1484684	135982
18	1592491	150993	1570957	152400
19	1679817	168179	1657049	169742
20	1766957	186281	1742950	188010
21	1853902	205297	1828650	207199
22	1940643	225225	1914138	227308
23	2027170	246064	1999405	248334
24	2113472	267810	2084442	270275
25	2199543	290461	2169237	293129
26	2285370	314015	2253782	316893
27	2370945	338470	2338068	341564
28	2456258	363822	2422083	367138
29	2541301	390068	2505819	393615
30	2626063	417207	2589264	420989

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 39°.		Latitude 40°.	
	x.	*y*.	*x*.	*y*.
1°	86614	476	85382	479
2	173218	1903	170753	1916
3	259801	4281	256103	4310
4	346352	7610	341420	7662
5	432862	11889	426695	11971
6	519320	17118	511915	17236
7	605715	23297	597071	23456
8	692037	30424	682153	30632
9	778275	38499	767147	38762
10	864419	47520	852045	47845
11	950460	57487	936837	57879
12	1036385	68399	1021510	68865
13	1122186	80254	1106055	80799
14	1207851	93050	1190461	93681
15	1293371	106787	1274717	107509
16	1378733	121462	1358813	122282
17	1463931	137073	1442738	137997
18	1548951	153620	1526481	154653
19	1633784	171099	1610031	172247
20	1718421	189509	1693379	190777
21	1802850	208848	1776514	210241
22	1887062	229112	1859426	230637
23	1970045	250301	1942103	251961
24	2054791	272410	2024537	274212
25	2138290	295439	2106714	297386
26	2221530	319382	2188627	321481
27	2304504	344239	2270264	346492
28	2387197	370005	2351617	372418
29	2469603	396678	2432673	399256
30	2551712	424258	2513422	427000

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 41°.		Latitude 42°.	
	x.	*y.*	*x.*	*y.*
1°	84123	481	82839	484
2	168235	1926	165666	1935
3	252326	4334	248471	4353
4	336382	7705	331243	7738
5	420395	12038	413969	12090
6	504353	17332	496638	17407
7	588245	23587	579240	23690
8	672060	30803	661762	30936
9	755786	38978	744195	39146
10	839414	48111	826526	48317
11	922931	58200	908744	58451
12	1006327	69246	990839	69541
13	1089591	81246	1072798	81593
14	1172713	94198	1154610	94600
15	1255680	108101	1236266	108561
16	1338484	122953	1317753	123475
17	1421111	138753	1399060	139339
18	1503552	155497	1480176	156152
19	1585796	173184	1561090	173911
20	1667833	191812	1641791	192614
21	1749651	211378	1722270	212258
22	1831238	231880	1802512	232840
23	1912587	253314	1882509	254358
24	1993684	275679	1962249	276809
25	2074520	298970	2041721	300189
26	2155084	323186	2120915	324496
27	2235366	348322	2199820	349727
28	2315354	374376	2278425	375877
29	2395038	401344	2356718	402943
30	2474408	429223	2434691	430921

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 43°.		Latitude 44°.	
	x.	y.	x.	y.
1°	81529	485	80194	486
2	163047	1941	160377	1944
3	244541	4367	240536	4375
4	326001	7762	320660	7777
5	407415	12127	400737	12150
6	488771	17461	480754	17494
7	570058	23763	560702	23807
8	651264	31032	640566	31089
9	732378	39267	720337	39339
10	813387	48466	800001	48556
11	894282	58630	879549	58737
12	975050	69755	958967	69883
13	1055680	81841	1038243	81990
14	1136160	94887	1117367	95058
15	1216479	108889	1196327	109084
16	1296627	123846	1275112	124066
17	1376590	139756	1353708	140002
18	1456357	156616	1432106	156890
19	1535920	174425	1510294	174727
20	1615264	193180	1588258	193511
21	1694380	212877	1665990	213238
22	1773254	233516	1743477	233907
23	1851878	255091	1820708	255514
24	1930240	277602	1897670	278055
25	2008328	301042	1974355	301527
26	2086132	325410	2050748	325928
27	2163640	350703	2126840	351253
28	2240841	376917	2202620	377498
29	2317726	404048	2278076	404661
30	2394281	432092	2353197	432736

TABLE II.

Co-ordinates of Curvature—Continued.

Longitude.	Latitude 45°.		Latitude 46°.	
	x.	y.	x.	y.
1°	78835	486	77452	486
2	157659	1946	154892	1945
3	236458	4378	232307	4375
4	315221	7782	309685	7778
5	393936	12158	387015	12152
6	472591	17505	464284	17495
7	551175	23823	541480	23809
8	629674	31109	618590	31091
9	708078	39364	695603	39341
10	786373	48586	772506	48557
11	864549	58774	849287	58738
12	942594	69925	925935	69882
13	1020495	82039	1002437	81987
14	1098239	95113	1078780	95052
15	1175817	109145	1154953	109074
16	1253215	124134	1230945	124053
17	1330423	140077	1306742	139982
18	1407428	156972	1382334	156863
19	1484219	174816	1457707	174691
20	1560784	193605	1532851	193465
21	1637111	213339	1607754	213180
22	1713189	234013	1682402	233834
23	1789006	255624	1756786	255423
24	1864550	278169	1830893	277945
25	1939811	301645	1904711	301395
26	2014775	326048	1978228	325770
27	2089434	351373	2051435	351067
28	2163773	377619	2124317	377280
29	2237784	404780	2196866	404406
30	2311449	432852	2269067	432441

TABLE II.

Co-ordinates of Curvature—Continued.

Longitude.	Latitude 47°.		Latitude 48°.	
	x.	*y*.	*x*.	*y*.
1°	76045	485	74614	484
2	152077	1941	149216	1935
3	228085	4368	223792	4354
4	304055	7764	298331	7741
5	379976	12130	372820	12093
6	455835	17464	447246	17411
7	531619	23766	521597	23695
8	607317	31035	595860	30942
9	682916	39270	670022	39151
10	758404	48469	744073	48322
11	833768	58631	817997	58452
12	908997	69754	891784	69541
13	984077	81836	965421	81584
14	1058997	94876	1038896	94584
15	1133745	108871	1112197	108534
16	1208307	123819	1185309	123434
17	1282673	139717	1258223	139281
18	1356830	156563	1330925	156072
19	1430766	174354	1408403	173805
20	1504467	193088	1475645	192476
21	1577926	212761	1547639	212083
22	1651126	233370	1619372	232622
23	1724058	254912	1690833	254090
24	1796708	277382	1762009	276482
25	1869066	300779	1832889	299796
26	1941119	325097	1903461	324027
27	2012856	350332	1973712	349172
28	2084265	376481	2043631	375225
29	2155335	403540	2113207	402183
30	2226052	431504	2182427	430042

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 49°.		Latitude 50°.	
	x.	y.	x.	y.
1°	73161	482	71685	479
2	146309	1927	143357	1917
3	219432	4336	215003	4312
4	292516	7708	286611	7666
5	365550	12042	358168	11976
6	438521	17338	429661	17243
7	511415	23594	501077	23465
8	584220	30810	572403	30641
9	656925	38985	643627	38771
10	729515	48116	714736	47851
11	801979	58203	785718	57882
12	874303	69243	856558	68861
13	946476	81235	927246	80786
14	1018485	94177	997768	93655
15	1090317	108065	1068111	107465
16	1161959	122899	1138264	122215
17	1233401	138676	1208213	137902
18	1304628	155392	1277946	154522
19	1375629	173044	1347451	172073
20	1446391	191631	1416715	190552
21	1516902	211147	1485725	209955
22	1587150	231591	1554471	230279
23	1657123	252958	1622938	251520
24	1726808	275246	1691115	273675
25	1796193	298449	1758990	296739
26	1865267	322564	1826550	320709
27	1934017	347587	1893784	345580
28	2002432	373513	1960680	371347
29	2070500	400338	2027224	398006
30	2138207	428058	2093407	425553

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 51°.		Latitude 52°.	
	x.	*y.*	*x.*	*y.*
1°	70186	476	68667	472
2	140360	1904	137322	1888
3	210510	4284	205950	4249
4	280618	7614	274541	7553
5	350676	11896	343078	11801
6	420671	17126	411549	16990
7	490586	23307	479946	23120
8	560411	30434	548249	30192
9	630133	38510	616451	38202
10	699742	47530	684534	47146
11	769219	57490	752487	57030
12	838555	68398	820300	67845
13	907736	80240	887956	79592
14	976753	93020	955446	92273
15	1045588	106733	1022753	105873
16	1114230	121382	1089866	120401
17	1182670	136963	1156777	135850
18	1250890	153465	1223466	152219
19	1318880	170893	1289926	169504
20	1386627	189240	1356139	187699
21	1454119	208503	1422095	206804
22	1521346	228686	1487785	226818
23	1588290	249775	1553192	247726
24	1654943	271771	1618307	269540
25	1721292	294670	1683114	292242
26	1787322	318465	1747603	315836
27	1853027	343153	1811762	340312
28	1918390	368730	1875577	365669
29	1983398	395193	1939040	391900
30	2048043	422532	2002133	418984

TABLE II.

Co-ordinates of curvature—Continued.

Longitude.	Latitude 53°.		Latitude 54°.	
	x.	y.	x.	y.
1°	67127	468	65567	463
2	134241	1871	131117	1851
3	201329	4210	196645	4165
4	268378	7483	262131	7404
5	335375	11692	327566	11567
6	402304	16832	392937	16654
7	469157	22906	458226	22664
8	535920	29911	523427	29595
9	602576	37845	588521	37445
10	669119	46707	653500	46212
11	735530	56498	718347	55899
12	801798	67215	783052	66497
13	867910	78850	847602	78010
14	933854	91407	911980	90431
15	999614	104880	976178	103765
16	1065180	119274	1040184	118002
17	1130540	134578	1103977	133140
18	1195684	150791	1167554	149178
19	1260594	167908	1230894	166110
20	1325260	185930	1293993	183936
21	1389665	204853	1356834	202650
22	1453800	224670	1419401	222250
23	1517653	245381	1481688	242732
24	1581213	266977	1543671	264092
25	1644465	289457	1605360	286323
26	1707398	312820	1666725	309430
27	1769999	337055	1727754	333393
28	1832256	362163	1788440	358218
29	1894155	388131	1848761	383897
30	1955688	414965	1908730	410425

APPENDIX No. 34.

Description of an apparatus devised by Assistant W. P. Trowbridge, and of the method of applying it in determining ocean depths and obtaining specimens of bottom.—(Sketch No. 40.)

U. S. Coast Survey Office, *April* 6, 1859.

Dear Sir: In my report to you of May 31, 1858, I had the honor of presenting the results of an investigation of the laws of descent of heavy bodies in the ocean, under the conditions required in deep-sea sounding.

The object of that investigation was to ascertain and develop fully the causes of failure and error in deep soundings, and to devise a more certain and reliable mode of measuring the depth of the ocean in the off-shore hydrography of the Coast Survey, and especially in the swift current of the Gulf Stream.

I have now to present for your further consideration a sounding apparatus based upon the developments given in my former report, and the result of further study and experiments on the subject.

The distinguishing feature of the method herein described, though exceedingly simple in its application, has never before been proposed, inasmuch as its necessity could hardly have been felt without a careful analysis of the circumstances of descent of the sounding lead and line. In the method of sounding heretofore employed, the influence of the friction of the water upon the line, or "endwise resistance," as it is called by Prof. Airy, was known to exist, but the amount of this endwise resistance in pounds, and its ultimate effects at great depths, had not been determined. It was supposed that by making use of a weight of thirty or forty pounds and a small fishing line, this resistance would be reduced to an inappreciable amount, or at least that its effect in retarding the descent of the lead would not be sufficient to destroy confidence in the results.

It appears, however, from the investigations referred to, that a weight, such as is ordinarily used in sounding, will be practically held in suspension at no very great depth, even when the line used is the smallest that will sustain the weight with safety in the air; and, in confirmation of this conclusion, the fact is well established that, notwithstanding repeated experiments made by the most skilful officers and with the utmost care, the bottom of the ocean has never been reached in its deepest parts; and even where the bottom has been attained, and specimens brought to the surface, the uncertainties of the results have given good grounds for controversy with regard to the depth.

These failures and uncertainties do not arise from the magnitude of the distance to be measured, nor from the impenetrability of the fluid through which the lead has to pass. Distances infinitely great and infinitely small in the universe, above and around us, have been measured with precision, and the unexplored depths of the ocean are occupied by a medium freely and equally penetrable at all depths. Yet, in this field—a field daily traversed by the commerce of the world—a distance of a few miles only has baffled all attempts to measure it.

The difficulty lies in the simple cause stated above, viz: the "endwise resistance," or friction upon the sounding line, which prevents the lead from going to the bottom where the depth is great.

The apparatus which I have devised is designed to avoid this friction upon the line, while at the same time the line is not dispensed with, but is made use of as in the ordinary mode.

Before describing this apparatus, I will briefly refer to some of the results given in my previous report on this subject.

The rate of descent of an iron globe or sphere, as the simplest geometrical form, was first determined when falling freely in the ocean, and it was found that a sphere will attain a certain maximum velocity within twenty-five feet of the surface, which velocity will be kept up without sensible increase or diminution to the bottom.

For a 32-pound iron shot this uniform velocity is about sixteen feet per second.

The conditions of descent when a small line is attached to the sphere and drawn down with it were then discussed, the line being uncoiled from a reel on the deck of the vessel, and drawn down by the weight of the sphere. The friction of this line in the water causes a remarkable change in the rate of descent. Nearly the same maximum velocity at starting is obtained, but the velocity becomes rapidly reduced until the sphere becomes suspended nearly motionless in the water.

Taking the simple case af a 32-pound shot attached to a small fishing line, the shot attains its maximum velocity of sixteen feet per second within twenty-five feet of the surface; but before a hundred fathoms of the line is drawn into the water this velocity is reduced to eight feet per second—a diminution of half the velocity from the friction of one hundred fathoms of line.

At five hundred fathoms the velocity is again reduced half, or to four feet per second; and at three thousand, to about one foot per second; *whereas at this depth, if there is no line attached, the shot will fall with its original velocity of sixteen feet per second undiminished.* Below this depth we may determine in the same way the circumstances in the two cases; the shot falling freely still retains its uniform velocity of sixteen feet per second at four, five, and six thousand fathoms depth; while with the line attached, at five thousand fathoms the velocity is reduced to a few inches per second, and at six thousand fathoms the descent is not perceptible under ordinary circumstances.

The time of descent becomes an important element also in practice. In the two cases given the shot falling freely will descend to the depth of three thousand fathoms in twenty minutes, and to the depth of six thousand fathoms in forty minutes; while, with the line attached, it will require two hours to descend three thousand fathoms, and eight hours to descend six thousand fathoms.

These effects were shown to be due to the friction alone; the amount of which in pounds was determined for different cases in which different forms of weight and different sizes of lines were used; and the entire inapplicability of the ordinary mode of sounding for great depths, and even for ordinary depths, where the object is to obtain a correct knowledge of the depths, was demonstrated.

Methods have been proposed in which a line is dispensed with by detaching a float at the bottom when the plummet strikes, and watching for the return of the float to the surface; but this is impracticable, as there is no material applicable, within our knowledge, that will float to the surface from the bottom of the sea, on account of the great pressure which condenses the bulk, so as to render bodies specifically lighter than water at the surface heavier than water at even moderate depths. A line must therefore be used to bring back to the surface, any machine by which the depth may be registered in the descent, and the motion of this line in an extended form in the water must be avoided.

The apparatus which I have devised is designed to secure this object by attaching to the sinker a tube or case in which the sounding line is compactly coiled, and from which it will be

discharged freely, thus causing the plummet to carry down the *coil*, while one end of the line is held fast at the surface; the line being uncoiled from the descending sinker, in the manner that a spider falling from a height gives out a thread in his descent by which he retains communication with the point above to which the thread is attached. The motion of the line in an extended form through the water being thus avoided, all the conditions of free descent are secured, and the plummet will descend to the greatest depths with a rapid and uniform velocity.

The depth is ascertained in the manner heretofore known as Massey's method, by a helix or curved blade, which is caused to revolve by the motion of the apparatus through the water. Instead of Massey's Indicator, however, which from its faulty construction does not give accurate results, I have adapted Saxton's Current Metre, a much more delicate instrument, to this purpose.

A specimen tube is also used, differing somewhat from those now in use in construction, but not in its essential points.

The lower end of the line is attached to the register and to the specimen box, which weigh together only two or three pounds; and as the line is hauled in from the bottom it brings up the register and specimen box, leaving the plummet and attached case at the bottom.

The details of construction are shown in the accompanying drawings and description of the apparatus.

Besides overcoming the principal difficulty in sounding, there are other important advantages secured by this arrangement which simplify rather than complicate the problem. These are as follows:

First. There is no strain upon the line in the descent, except from its own weight, no matter to what depth or with what velocity the plummet may descend. It is possible, therefore, to employ a very small line; a single thread of silk may, in fact, be extended to the bottom of the ocean. This permits of the use of a line which may be coiled compactly within a small space, the strength of the line being made just sufficient to insure its being hauled in with safety, bringing up at the same time the specimen box and the register. The strain brought upon it in hauling in will depend upon the velocity of the upward motion, which may be regulated accordingly.

Secondly. A *rapid* and *uniform* descent being secured, the indications of a revolving register will be reliable when attached to this plummet, while in the present mode of sounding the slow motion of descent at great depths renders such a mode of registering the depth uncertain and unreliable.

Thirdly. There being no strain upon the line in the descent, and the motion being *uniform*, it is practicable to determine the depth by the time of descent, making use of a small insulated wire as a sounding line, and determining the instant that the weight strikes the bottom by an electrical signal transmitted through the line. An apparatus was devised as long since as the year 1845, for ascertaining the moment when the weight strikes the bottom by electricity, but in the mode of sounding heretofore employed no particular advantage would result from this, while the danger of breaking the electric continuity is very great, owing to the strain brought upon the line in the descent; and the plummet as now used descends with such a varying velocity that even with the time of descent given no calculation will give the depth. The method has, therefore, never been put in practice. Whereas, in the method proposed, there is no strain upon the line in its descent, and the plummet will fall through each successive

hundred fathoms in the same time; *the time of descent will thus furnish a simple means of calculating the depth.* In this process it will not be necessary to recover the line, and the time required to sound the ocean at any point need only be that required for the plummet to sink to the bottom, moving with any velocity which may be desired.

I have made many experiments on the best method of coiling the line so as to secure its uncoiling with certainty, and without the possibility of a strain upon the line or the occurrence of a kink. I have also given much attention to the quality and size of the line to be used. Upon these points the practical working of the apparatus in a certain degree depends, but being merely mechanical questions they are easily settled. They are fully discussed in the description which accompanies the drawings.

The importance of the problem which is thus sought to be solved, in connection with the survey of the coast, has never been questioned; a knowledge of the configuration of the bottom of the sea adjacent to the coast is necessary to the solution of many questions of importance to navigation and to science, and especially that of the ruling feature of the Atlantic Coast, the Gulf Stream; but besides these considerations the question has become one of great public interest in connection with the laying of submarine telegraphs, the risks of such enterprises being diminished in proportion to the accuracy with which the depth of the sea is known at every point of any proposed line, and the ultimate practicability of such operations across the Atlantic being yet to be demonstrated by new and more accurate soundings.

Description.

The accompanying plate (Sketch No. 39) represents the instrument as at first constructed. Some slight modifications have since been made in the mode of attaching the register, but without affecting the general design.

Fig. 1 represents the plummet as it appears in its descent.

T, the tube or case containing the coiled line.

W, the leaden or iron weight inserted in the bottom of the tube.

C, the conical cap.

R, the register in its place upon the cap.

L, the line.

Fig. 1 *a* represents a longitudinal section of the tube, weight, and cap, showing the mode of coiling the line in balls, and the small specimen box *s* passing through the hollow weight.

Fig. 2 represents the register on a larger scale.

h h, the helices or blades.

r r, the register wheels.

g g, the locks for gearing and ungearing the wheels.

Fig. 2 *a* represents the plan or horizontal view of the register, it being constructed so as to offer the least resistance in passing through the water.

Fig. 3 shows the detailed construction of the register wheels and the helices.

From Fig. 1, it will be seen that the form of the apparatus admits of rapid motion through the water. The weight is conical and elongated and the register presents the edges only of brass plates to the water, and the line being uncoiled and discharged from the tube there is no

retarding force to the descent from the line itself. Any desired velocity of descent may be given to the plummet by increasing or decreasing the weight W.

Fig 1 *a* shows the method of coiling the line.

There are various modes of doing this which are in common practice in twine and cotton factories; that which is here exhibited is the method of coiling in balls, all the balls exhibited in the tube being formed of one unbroken line, the line drawing out from the centre of each, until it is all drawn from the tube. The machinery for winding these balls is very simple.

The essential points in the coiling are to coil the line in as compact a space as possible, so as to insure certainty of discharge without danger of kinking. Two other modes of coiling are now under consideration, either of which may be better than the method by balls. One is to wind upon a spindle, and the other to lay the line in a sort of compound coil, directly in the tube. All these methods are now practiced in the factories on a large scale for winding twine and cotton.

The line used should be about five hundredths of an inch in diameter, and as strong as it can be made of that size. A braided line of Holland flax or silk of five hundredths of an inch in diameter may be made to bear a strain of forty or fifty pounds, which is abundantly strong for the purpose, as the weight and case are left at the bottom, the register and specimen tube only being brought up.

Tube.

The tube may be made of tin in sections of eighteen inches in length, with stove-pipe joints and bayonet fastenings. The object of this is to adapt the length of the tube readily to the amount of line which it is to contain. A tube four inches in diameter will contain nearly a mile of line to each foot of the tube.

Sinker and specimen tube.

The sinker is made of cast iron or lead of any desired weight, depending upon the desired velocity of descent. A weight of twenty-five pounds has been adopted.

The sinker is conical and is inserted into the lower end of the tube containing the line and fastened to this tube by screws or by a bayonet joint and fastening. The weight has a conical hole or cavity through its entire length, through which the small specimen tube passes in the manner shown in the drawing.

The specimen tube is a tube of thin brass passing through the weight and attached to the lower end of the line within the large tube. This specimen tube is fitted with a valve opening upwards in the bottom, which closes when the tube is drawn up, thus retaining the mud which is forced into the tube when the weight strikes bottom. The specimen tube fits loosely in the bottom of the weight so that it may be easily drawn out as the line is hauled in.

Cap.

The cap is used for two purposes: to contract the upper end of the tube containing the line so that the line cannot rise in bulk out of the tube, and for supporting the register. It is formed in the shape of the frustum of a cone, cut away on one side as well as open at the top, so as to allow the line to be discharged freely. A flat strap is fastened to the top of the frustum nearly in the line of the axis of the tube, and upon this strap the register is set, as shown in the drawing; the register is kept in its place by loose collars.

Register.

The apparatus for measuring the depth consists of a helix or curved blade attached to a vertical axis, and wheels gearing into an endless screw upon this axis. The revolutions of the helix, caused by the motion through the water, are communicated to the wheels, which are graduated so as to indicate the number of revolutions of the helix.

Two registers are attached to one plummet by attaching them together in the manner shown in figure 2, by means of brass plates. The blades are made to turn in opposite directions, and will operate as checks upon each other, and also counteract the effect of any rotary motion in the plummet.

The construction of the blades and wheels and the mode of gearing them with the endless screw are shown in figure 3. The wheels are differential wheels; that is, they are concentric, one of them having one hundred teeth and the other one hundred and one teeth. The cross bar (*b*) has a slight motion, carrying with it the wheels; this motion is governed by a spring *s*. To gear the wheels the cross bar is pressed towards the endless screw until the teeth gear with that screw and the bar is there locked, as shown in figure 2 at *gg*. The revolution of the blades will now cause both wheels to turn, and after one hundred revolutions the wheels will be found separated by one tooth or one division. The differences thus measure hundreds of revolutions. In the register from which the drawings were made, the blades revolve once in two feet; one hundred revolutions will therefore correspond to two hundred feet, or one division of the scale of the register to thirty-three fathoms.

When the register is hauled up, the arms at *gg*, figure 2, drop, and the springs cause the wheels to ungear and fly back, where they are held motionless by a projecting point at *n*, figure 3. The arms are made to drop by means of a small wire, which is attached to the cap, as shown at (*u*,) figure 1. This wire is fastened to, or hooks over the ends of the arms, and when the register is drawn off, the arms fall.

Mode of attaching the line to the register and specimen tube.

Before the line is put into the tube it is attached to the specimen tube at a point four or five feet from the end of the line, the spare end is passed through the tube, and when the balls are all put in the tube the extreme end of the line coming out at top is attached to the register, after taking a few turns around the top of the strap, the register being in its place.

The line is thus attached to the specimen tube and register only, and not to the large tube or weight.

When the plummet strikes the bottom a part of the line will remain in the tube coiled; by hauling in the line this part will, however, be uncoiled, and on coming to the bottom of the coil the specimen tube will be drawn up through the large tube, and after the specimen tube comes out the register will be drawn off the strap, and thus the large tube and weight will be disengaged from the line, specimen tube, and register, and by continuing to haul in, the register and specimen tube will be brought to the surface. The plummet on striking will, under most circumstances, remain sticking in the mud in an upright position.

Very respectfully, your obedient servant,

W. P. TROWBRIDGE,
Assistant Coast Survey.

A. D. BACHE, LL.D.,
Superintendent U. S. Coast Survey.

APPENDIX No. 35.

Extracts from letters of J. M. Batchelder, esq., stating the results of trials made with Hunt's tide-metre at Charlestown navy yard, Mass.

BOSTON, *August* 30, 1859.

SIR: * * * Below are given the results of eighty observations made with the pressure tide-metre when the bag, tube, and guage were filled with air. The mean differences and error are also shown, but it is probable that the actual error is less than the result given in the column so designated, as the greatest difference occurred when the surface of the water was agitated, and the least when it was most calm.

To determine the effect produced by the escape of air, the bag was fully distended, and immersed to the depth of thirteen feet, and the position of the index noted. The instrument was then taken up and one-half of the air allowed to escape from the bag, but on being again immersed to the same depth the index remained as before.

No observations were made with reference to temperature, as the change of volume of the air from this cause would be very slight as compared with the distended and half-filled bag. * * * * .

Result of trials made with the pressure tide-meter at Charlestown navy yard in August, 1859.

Depth of immersion in feet.	1	2	3	4	5	6	7	8	Maximum.	Minimum.	Mean.
Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	2.92	2.97	2.87	2.90	2.90	3.06	2.92	2.90	3.06	2.87	2.93
1	3.87	4.02	3.96	3.96	3.87	4.03	3.96	3.98	4.02	3.87	3.96
2	4.83	5.00	4.94	4.99	4.95	5.00	5.00	4.95	5.00	4.83	4.96
3	5.86	5.90	5.87	5.87	5.93	5.93	5.90	5.88	5.93	5.86	5.89
4	6.87	6.97	6.86	6.97	6.97	7.00	6.97	6.99	7.00	6.86	6.95
5	7.85	7.85	7.86	7.85	7.80	7.92	7.87	7.80	7.92	7.80	7.85
6	8.87	8.82	8.91	8.82	8.78	8.86	8.93	8.86	8.93	8.78	8.86
7	9.83	9.80	9.87	9.75	9.83	9.86	9.75	9.75	9.87	9.75	9.80
8	10.87	10.89	10.90	10.83	10.83	10.99	10.83	10.83	10.90	10.83	10.86
9	11.90	11.94	11.91	11.91	11.91	11.99	11.90	11.86	11.99	11.86	11.91
10	12.80	12.92	12.87	12.87	12.87	12.87	12.84	12.84	12.92	12.80	12.86

Bag filled with air.

From the first mark (0) on the tube to the bottom of the air-vessel three feet.

Mean of eighty observations given above.

	Difference.	Error.
Feet.	*Feet.*	*Feet.*
2.93		
3.96	1.03	.03 +
4.96	1.00	.00
5.89	.93	.07 —
6.95	1.06	.06 +
7.85	.90	.10 —
8.86	1.01	.01 +
9.80	.94	.06 —
10.86	1.06	.06 +
11.91	1.05	.05 +
12.86	.95	.05 —

SEPTEMBER 17, 1859.

* * * Notes are here appended of further trials of the pressure tide-meter, made at your request, the instrument being filled with pure water.

It will be noticed that in the column headed "mean" we have on the third line 4.02 feet,
and when the water is .... 7.00 "

11.02 " higher,

as in the tenth line.

The intermediate observations would be equally accurate if the dial-plate of each instrument was graduated by marking the position of the index at each successive tenth of a foot immersed, beginning with a depth of not less than three or four feet. The bag, when in use, should always be at this depth below low-water mark.

The differences noted at the same depth of immersion (column nine) are mainly due to oscillation of the water, and in a very slight degree to friction of the index gear.

Trials made at Charlestown navy yard in September, 1859.

Diff. of depth of immersion in feet.	Observations 1.	Observations 2.	Observations 3.	Observations 4.	Observations 5.	Maximum.	Minimum.	Difference.	Mean.
Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
0	2.50	2.50	2.50	2.45	2.50	2.50	2.45	.05	2.49
1	3.00	3.10	3.08	3.00	3.00	3.10	3.00	.10	3.04*
2	4.05	4.05	4.05	3.98	3.97	4.05	3.97	.08	4.02
3	4.80	4.80	4.80	4.72	4.65	4.80	4.65	.15	4.75
4	5.65	5.70	5.60	5.58	5.55	5.70	5.55	.15	5.62
5	6.40	6.38	6.37	6.38	6.35	6.40	6.35	.05	6.38
6	7.60	7.62	7.56	7.60	7.50	7.62	7.50	.12	7.58
7	8.75	8.78	8.60	8.68	8.70	8.78	8.60	.18	8.70
8	10.02	10.02	9.90	9.83	9.90	10.02	9.83	.19	9.93
9	11.05	11.05	11.00	11.00	11.00	11.05	11.00	.05	11.02
10	12.05	11.95	11.95	12.05	12.00	12.05	11.95	.10	12.00
	12.00	12.10	12.08	12.00	12.00	12.10	12.00	....	12.04

* The figures on the last line are obtained by adding nine feet to those on the second.

To determine fully the practical value of this apparatus I think it should be set up with one of the common gauges, and the indications of each observed and compared daily for one or two months. * * * .

Very respectfully, your obedient servant,

J. M. BATCHELDER.

Prof. A. D. BACHE,

Superintendent United States Coast Survey.

APPENDIX No. 36.

Letter of the Secretary of the Treasury relative to placing the Coast Survey steamer Active under the authority of Brevet Lieut. General Scott.

TREASURY DEPARTMENT, *September* 16, 1859.

SIR: I have to inform you that, by direction of the President, the Coast Survey steamer "Active" has been placed under the authority of Brevet Lieutenant General Winfield Scott, United States army, and Commander James Alden, U. S. N., has been instructed by this department, under date of the 15th instant, to obey all orders emanating from him.

Very respectfully, your obedient servant,

HOWELL COBB,
Secretary of the Treasury.

Prof. A. D. BACHE,
Superintendent Coast Survey.

APPENDIX No. 37.

Letter of Captain John Pope, U. S. N., commandant at Portsmouth navy yard, addressed to Lieut. Comg. Alex'r Murray, U. S. N., Assistant Coast Survey, on the occasion of service rendered by the C. S. steamer Bibb.

U. S. NAVY YARD, *Portsmouth, N. H., October* 1, 1859.

SIR: Your promptness in answering a request to tow the United States ship Cumberland from the lower harbor to this navy yard on the 3d ultimo calls forth my acknowledgment and thanks, and I trust that your action will be approved by the Superintendent of the Coast Survey. Had you not rendered the assistance you did in towing up the Cumberland that vessel would have been detained by head winds five or six days in the lower harbor.

Very respectfully, your obedient servant,

JOHN POPE,
Commandant.

Lieut. Comg. A. MURRAY,
Coast Surveying Steamer Bibb.

APPENDIX No. 38.

Letter addressed to the Superintendent by Captain D. G. Farragut, U. S. N., on visiting Beaufort river, South Carolina, with the United States steamship Brooklyn.

UNITED STATES SLOOP-OF-WAR BROOKLYN,
Beaufort Roads, South Carolina, February 17, 1859.

SIR: Permit me thus to acknowledge the great service I have received from the Coast Survey, through the kindness of Mr. C. O. Boutelle, chief of the party encamped at Land's End, mouth

of Beaufort river, South Carolina, who volunteered his services, and handsomely piloted this ship up to within four and a half miles of the town of Beaufort and down again; and continued to extend every assistance and courtesy in his power during our stay in these waters.

Very respectfully, your obedient servant,

D. G. FARRAGUT,
Captain United States Navy.

Professor A. D. BACHE,
Superintendent Coast Survey, Washington city.

APPENDIX No. 39.

Letters addressed to Lieutenants T. A. Craven and J. N. Maffitt, U. S. N., on their detachment from the Coast Survey.

COAST SURVEY OFFCE, *June* 18, 1859.

DEAR SIR: I feel too deeply indebted for the sympathy and hearty co-operation manifested by you while attached to the Coast Survey to permit the occasion which returns you to general duty in the naval service to pass without expressing my sense of the value of your labors. Apart from the devotion shown as one of the naval assistants, it is natural to suppose that your early experience in the work gave enhanced interest to your later efforts, and I cannot but regard the long period of your co-operation in the survey as one of the happy incidents of my superintendence.

The large share which you have contributed to the hydrographic results of the Coast Survey would alone permanently associate your name with that national work. Those with whom you have acted will have also in memory the ready spirit for co-operation, the uniform courtesy, and the qualities of head and heart that never fail in contributing to success.

Receive, my dear sir, the assurance that my kind wishes will ever accompany you to whatever field of duty you may be called in the range of your profession.

Yours, respectfully and truly,

A. D. BACHE,
Superintendent U. S Coast Survey.

Lieut. Comg. T. A. M. CRAVEN,
United States Navy.

COAST SURVEY OFFCE, *June* 17, 1859.

DEAR SIR: I cannot permit the occasion to pass which severs your connection with the Coast Survey without expressing my deep sense of the value of your services while associated in that work. Where so many are employed, relative merits and special efficiency can be perceived and appreciated only by one charged with the general superintendence; and in that light it is now a pleasure to say that your labors in the prosecution of the hydrography must ever rank in my estimation as of the highest order. Your career during the extended period of your service, and since your recent assignment to Coast Survey duty, was marked by that

rare aptitude and intelligence in regard to the work which *assist* in planning, and by perseverance which left nothing to be desired in reference to the time of its execution. A comparison shows that in hydrographic results your efforts have been seldom if ever excelled by those of any other officer. The high estimation in which I have regarded them would be weakened by specification in addressing one so fully qualified for the widest range of duty in the naval profession. As nothing has occurred throughout the long period of your connection with the Coast Survey to stay the increasing regard won by your even courtesy and manly bearing, my regret in taking leave of you is the greater. I shall ever recur to your name as one of the most efficient of naval assistants of the Coast Survey with feelings of pride and pleasure.

Yours, respectfully,

A. D. BACHE,
Superintendent U. S. Coast Survey.

Lieut. Comg. J. N. MAFFITT,
United States Navy.

APPENDIX No. 40.

Aids to navigation recommended in reports made to the Superintendent by Assistants of the Coast Survey.

Sec.	Object.	By whom recommended.	Date of report, &c.
I.	Buoy on Huzzey's Rock, south of Fletcher's Neck, Wood island, Me.	Lieut. Comg. Alex. Murray, U. S. N.	Referred to the Light-house Board Oct. 15, 1859. (Appendix No. 41.)
I.	Buoy to mark the extremity of a sand spit near Fletcher's Neck, Wood island, Me.	do	Referred to the Light-house Board Oct 15, 1859. (Appendix No. 41.)
I.	Buoy to mark the position of Cashe's Ledge, off the coast of Mass.	do	Referred to the Light-house Board Sept. 15, 1859.
V.	Buoys to mark the Bird Key and Cow Pen channels, St. Helena sound, S. C.	Lieut. Comg. J. N. Maffitt, U. S. N.	Referred to the Light-house Board May 26, 1859. (Appendix No. 42)
V.	Buoys in the East channel, Port Royal sound, S. C.	Lieut. Comg. C. M. Fauntleroy, U. S. N.	Referred to the Light-house Board July 8, 1859. (Appendix No. 43.)

APPENDIX No. 41.

Letter to the Secretary of the Treasury, communicating recommendations from Lieut. Comg. Alexander Murray, U. S. N., Assistant Coast Survey, for buoys in the vicinity of Fletcher's Neck, coast of Maine.

PHILADELPHIA, *October* 15, 1859.

SIR: I have the honor to communicate the following extract from a letter addressed to me, under date of October 9, by Lieut. Comg. Alexander Murray, U. S. N., Assistant Coast Survey, and would respectfully request that a copy be furnished to the Light-house Board:

"In the place indicated on the enclosed sketch (coast of Maine) there is a rock whose position has been determined by this party. It is called *Huzzey's Rock;* and being very sharp, with three and four fathoms of water about it, and contiguous to 'Wood Island harbor,' is dangerous. I recommend that a buoy be placed near it.

"Between 'Nigger island' and 'Fletcher's Neck signal,' near the spot indicated by *red ink sand shoal-marks*, is the end of a *spit*. This is in the harbor, and should be marked with a *red buoy*, as, entering through the west channel, it would be on the *starboard hand*."

Very respectfully, yours,

A. D. BACHE,
Superintendent U. S. Coast Survey.

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 42.

Letter to the Secretary of the Treasury, communicating a recommendation from Lieut. Comg. J. N. Maffitt, U. S. N., Assistant in the Coast Survey, for placing buoys in St. Helena sound, S. C.

COAST SURVEY OFFICE, *May* 26, 1859.

SIR: I have the honor to present for the consideration of the Light-house Board the following extract from a communication addressed to me by Lieut. Comg. J. N. Maffitt, U. S. N., Assistant Coast Survey, under date of May 25:

"For the convenience of steamers in passing through the South Edisto river into St. Helena sound, S. C., two second class buoys should be placed in what is called the Bird Key and Cow Pen channel. These would enable steamers to pass with a great saving in distance, and in comparatively smooth water while the wind is blowing fresh.

"The commanders of the steamers 'Edisto' and 'Everglade' have felt the necessity for these aids in navigation, and would willingly furnish the use of their boats for establishing the buoys in their places."

The positions of the desired buoys are marked 3 and 4 on the enclosed tracing.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. HOWELL COBB,
Secretary of the Treasury.

APPENDIX No. 43.

Letter to the Secretary of the Treasury, communicating the recommendation of Lieut. Comg. C. M. Fauntleroy, U. S. N., Assistant Coast Survey, for buoys to mark the East channel into Port Royal sound, S. C.

CAMBRIDGE, MASSACHUSETTS, *July* 8, 1859.

SIR: In reporting the completion of soundings by the hydrographic party in the several channels of Port Royal entrance, S. C., Lieut. Comg. C. M. Fauntleroy, U. S. N., Assistant Coast Survey, suggests that the East channel passage should be buoyed out as soon as practicable.

The recommendation being based upon the results of his examinations, as shown by the hydrographic sheet, I would respectfully request that a copy of this communication may be transmitted to the Light-house Board.

Very respectfully, yours,

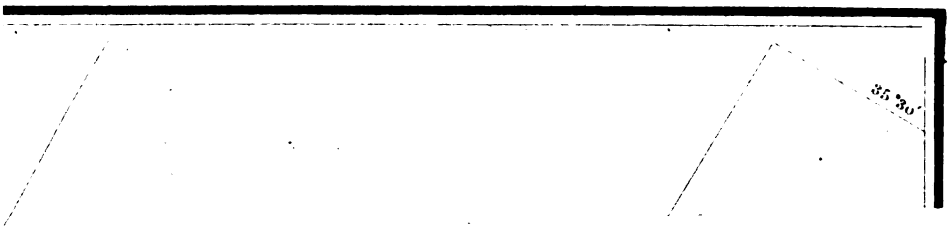
A. D. BACHE, *Superintendent.*

Hon. HOWELL COBB,
Secretary of the Treasury.

INDEX TO SKETCHES AND DIAGRAMS.

* Omitted.

No. 5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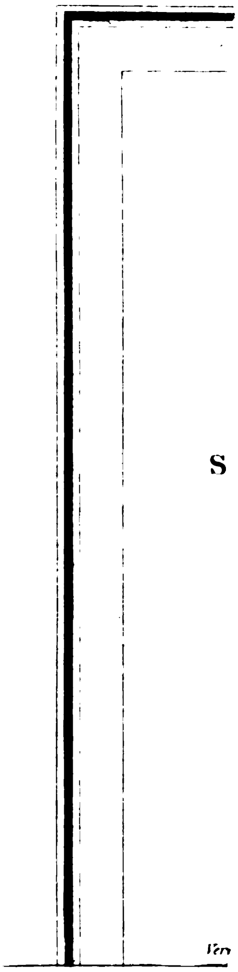

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C.S. In charge of Office.

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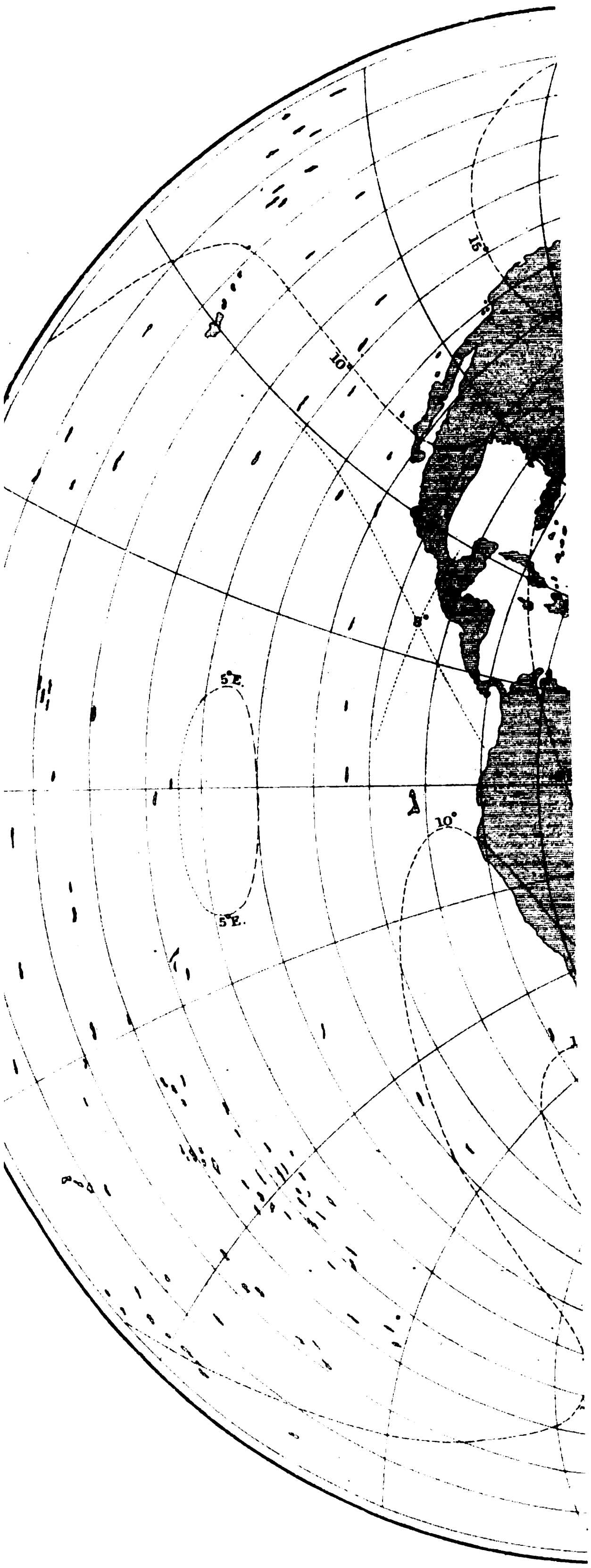
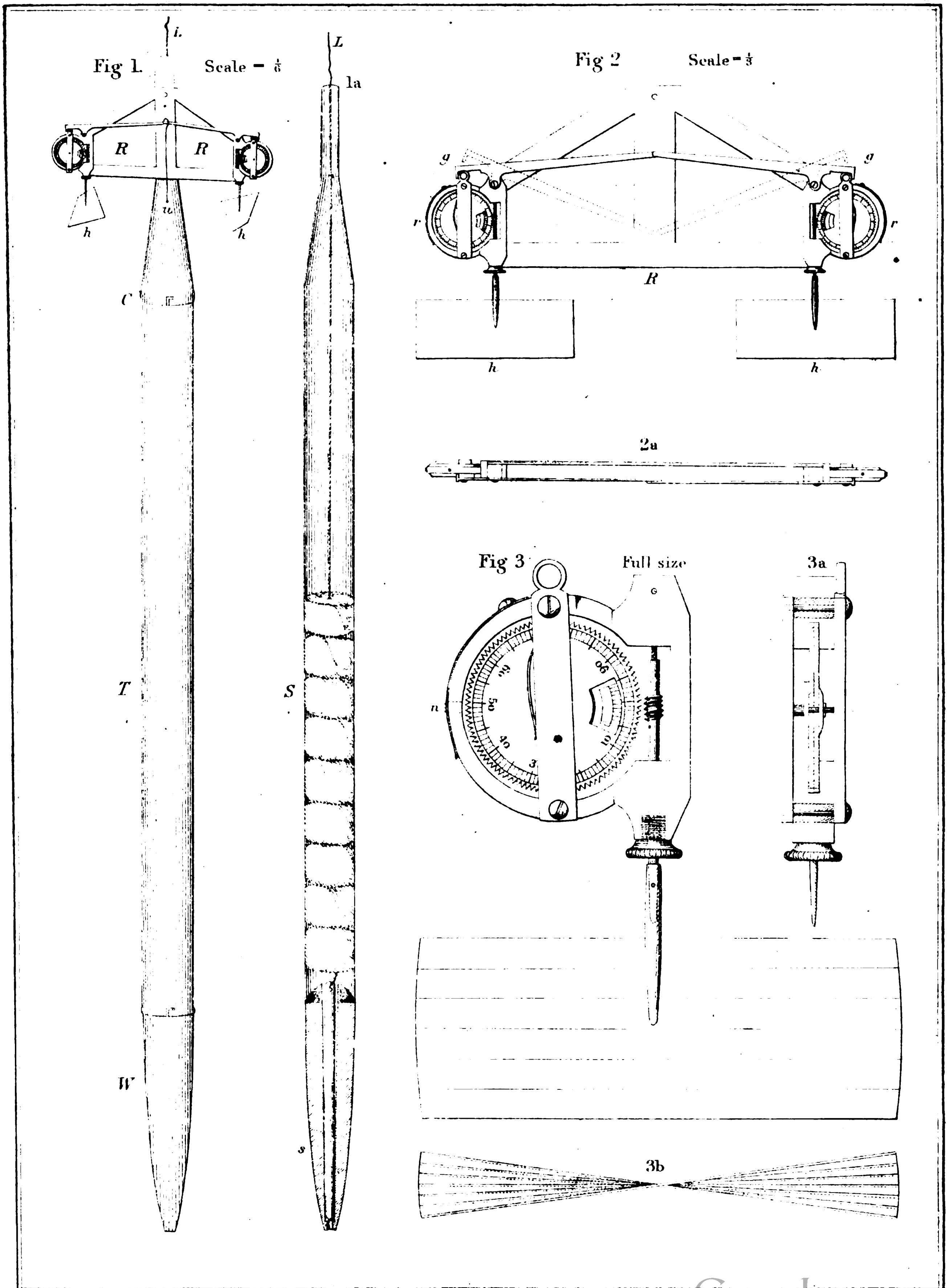


IMPROVED DEEP SEA SOUNDING APPARATUS



Eng.d by R. F. Bartle

No. 40